61 a 10

THE FIELD ENGINEER.

OF

M. le Chevalier DE CLAIRAC,

Tranſlated from the FRENCH,

WITH

OBSERVATIONS AND REMARKS
on each CHAPTER.

TOGETHER

With the Addition of ſeveral NEW FIGURES, on a large Copper-plate, to explain the AUTHOR'S CONSTRUCTIONS.

The SECOND EDITION CORRECTED, with ADDITIONS.

By JOHN MULLER,
Maſter of the Royal Academy at WOOLWICH.

LONDON:

Printed for JOHN MILLAN, oppoſite the Admiralty.

M DCC LXXIII.

[Price Seven Shillings and Six-pence Bound.]

BOOKS publiſhed by J. MILLAN, Bookſeller, oppoſite the Admiralty, Whitehall, 1772.

1 MULLER's Works of Fortification, Engineering, Mining, Artillery, Mathematics, &c. containing upwards of 200 Cuts, with large Additions, 8 vol. 2l. 8s. 6d.

2 The Military Guide, containing a Syſtem of the Art of War, Parade, Camp, and Field Duty, Manœeuvres, ſtanding and general Orders, Warrants, Regulations, Tables, Forms, Returns, the Duke of Cumberland's Orders, &c. for his Majeſty's Land Forces. An accurate Account of the moſt remarkable Battles, Sieges, Fortifications, Forts, Ports, &c. a Military Dictionary, with 24 Copper-plates, Maps, &c. including every Duty from the Commander to the Soldier. Collected from the beſt Authorities, by Capt. Simes.

3 Capt. Miller's Art of Fencing, with the Broad Sword, Sword and Dagger, Sword and Buckler, Sword and Gauntlet, Hanger and Quarter ſtaff, &c. ornamented with Borders on 18 large Copper-plates, deſigned and engraved by Gravelot and Scotin. Price 1 l. 1s. ſubſcribed at 2 l. 2s. N. B. Whole length Figures were from his Pupils and Patrons, to whom the Plates are dedicated, with their arms and ſupporters.

4 Capt. Simes's Military Medley and Military Dictionary, with large Additions, 2d Edit. 10s. 6d.

5 Vegetius's antient Art of War with Notes, by Capt. Clarke, 5s.

6 Diſcipline for the Norfolk Militia, 2d Edition with Additions, and 55 large Copper plates, by Lord Townſhend, &c. 10. 6d.

7 Major Young's Manœeuvres, and new Syſtem of Fortification, Wolfe, &c. with large Additions, 10s. 6d.

8 New Exerciſe by his Majeſty's Order, 1s.

9 Recruiting Book for all Officers in the Army, 2s. 6d.

10 Regimental Book, beautifully engraved, 4 l. 4s.

11 General Returns for reviewing Horſe, Dragoons, and Foot.

12 All the ſtanding Orders, Regulations, &c. for the Army.

13 New Pruſſian Field Regulations for Foot, 17 Cuts, 4to. 7s. 6d.

14 Liſt of the Forces of above 40 Sovereigns, &c. Ranks, Uniforms, Number of Officers, Private Men, &c. neatly coloured, 10s. 6d.

15 The Value of Commiſſions on Full and Half Pay, with the Difference ſettled by the King's Command, 2s.

16 New Art of War, by Capt. Anderſon, 7s. 6d.

17 Artificial Fire-works, improved with 60 Figures, by Capt. Jones, the 2d. Edition, with Additions of three Plates, &c

18 Voyages and Travels from original Manuſcripts, &c. from the Harlean Library, 2 vol. Folio, proper to be added to the ſix Volumes of Voyages and Travels in Folio, formerly ſold for 3 l. 3s. but now ſold for 2 l. 2s.

THE EDITOR TO THE READER.

THE Author being an Engineer of high rank in the French army, had great opportunities to improve his knowledge; during a long courſe of experience, he conſidered, that though many have wrote upon the conſtruction of permanent fortification, as well as the attac and defence of places, yet little had been wrote in regard to the requiſite knowledge of an engineer in the field, which he very juſtly thinks to be as neceſſary as any other part; for which reaſon, he imagined a work of this kind would meet with general approbation; as he has wrote upon very little but what he has ſeen and ordered to be executed, and having beſides, the qualification of a good writer, it is no wonder that his work has been ſo much eſteemed as to go thro' ſeveral editions.

EVERY officer may not be ſo well verſed in the French, as to read the original, or perhaps

BOOKS publiſhed by J. MILLAN, Bookſeller, oppoſite the Admiralty, Whitehall, 1772.

1 MULLER's Works of Fortification, Engineering, Mining, Artillery, Mathematics, &c. containing upwards of 200 Cuts, with large Additions, 8 vol. 2l. 8s. 6d.

2 The Military Guide, containing a Syſtem of the Art of War, Parade, Camp, and Field Duty, Manœeuvres, ſtanding and general Orders, Warrants, Regulations, Tables, Forms, Returns, the Duke of Cumberland's Orders, &c. for his Majeſty's Land Forces. An accurate Account of the moſt remarkable Battles, Sieges, Fortifications, Forts, Ports, &c. a Military Dictionary, with 24 Copper-plates, Maps, &c. including every Duty from the Commander to the Soldier. Collected from the beſt Authorities, by Capt. Simes.

3 Capt. Miller's Art of Fencing, with the Broad Sword, Sword and Dagger, Sword and Buckler, Sword and Gauntlet, Hanger and Quarter ſtaff, &c. ornamented with Borders on 18 large Copper-plates, deſigned and engraved by Gravelot and Scotin. Price 1 l. 1s. ſubſcribed at 2 l. 2s. N. B. Whole length Figures were from his Pupils and Patrons, to whom the Plates are dedicated, with their arms and ſupporters.

4 Capt. Simes's Military Medley and Military Dictionary, with large Additions, 2d Edit. 10s. 6d.

5 Vegetius's antient Art of War with Notes, by Capt. Clarke, 5s.

6 Diſcipline for the Norfolk Militia, 2d Edition with Additions, and 55 large Copper plates, by Lord Townſhend, &c. 10. 6d.

7 Major Young's Manœeuvres, and new Syſtem of Fortification, Wolfe, &c. with large Additions, 10s. 6d.

8 New Exerciſe by his Majeſty's Order, 1s.

9 Recruiting Book for all Officers in the Army, 2s. 6d.

10 Regimental Book, beautifully engraved, 4 l. 4s.

11 General Returns for reviewing Horſe, Dragoons, and Foot.

12 All the ſtanding Orders, Regulations, &c. for the Army.

13 New Pruſſian Field Regulations for Foot, 17 Cuts, 4to. 7s. 6d.

14 Liſt of the Forces of above 40 Sovereigns, &c. Ranks, Uniforms, Number of Officers, Private Men, &c. neatly coloured, 10s. 6d.

15 The Value of Commiſſions on Full and Half Pay, with the Difference ſettled by the King's Command, 2s.

16 New Art of War, by Capt. Anderſon, 7s. 6d.

17 Artificial Fire-works, improved with 60 Figures, by Capt. Jones, the 2d. Edition, with Additions of three Plates, &c.

18 Voyages and Travels from original Manuſcripts, &c. from the Harlean Library, 2 vol. Folio, proper to be added to the ſix Volumes of Voyages and Travels in Folio, formerly ſold for 3 l. 3s. but now ſold for 2 l. 2s.

THE EDITOR TO THE READER.

THE Author being an Engineer of high rank in the French army, had great opportunities to improve his knowledge; during a long courſe of experience, he conſidered, that though many have wrote upon the conſtruction of permanent fortification, as well as the attac and defence of places, yet little had been wrote in regard to the requiſite knowledge of an engineer in the field, which he very juſtly thinks to be as neceſſary as any other part; for which reaſon, he imagined a work of this kind would meet with general approbation; as he has wrote upon very little but what he has ſeen and ordered to be executed, and having beſides, the qualification of a good writer, it is no wonder that his work has been ſo much eſteemed as to go thro' ſeveral editions.

EVERY officer may not be ſo well verſed in the French, as to read the original, or perhaps

ſufficiently acquainted with the ſubject, it is hoped that a Tranſlation, with proper explanations, will prove acceptable. Where ſome parts are expreſſed in a ſhort and abrupt manner, the terms wanting to render the Author's meaning more conſpicuous, have been ſupplied; the ſame liberty has been taken with his expreſſions, when neceſſary to render the work more intelligible; ſo that no literal tranſlation has been attempted.

I have added a new Plate, to explain his conſtructions, which few readers would have underſtood from his own words. Obſervations at the end of every chapter, to explain it. All poſſible care has been taken to explain every ſubject, in ſuch a manner, that any who have the leaſt ſkill in drawing may underſtand every part of it.

PREFACE.

THE knowledge neceſſary for an engineer is of two different kinds, one ſpeculative, demonſtrable, and conſequently invariable, ſerving as general principles, and making part of what is directly called Science; the other more practical and arbitrary, immediately comprehends the different objects of his profeſſion.

We have a ſufficient number of Treatiſes on elementary and practical Geometry, Algebra, Mechanics, and Hydraulics, &c.

If thoſe ſciences, that is, thoſe parts of the mathematics neceſſary to be known, previous to an examination, were all that is neceſſary for the theory, it is plain that all the aſſiſtance requiſite is to be had; but to imagine it thus confined, is not to know the extent it may, or ſhould have.

Independent of this ſpeculative, and preliminary theory, there is a practical part, which from ideas, carefully examined, ſhews the moſt eligible means of attaining the end propoſed, and procures us the ſecond part of knowledge neceſſary.

Though theſe two parts are equally neceſſary, we are as much at a loſs for the means of acquiring one, as we are abundantly provided for the other.

The reaſon of this difference is evident: to treat of ſpeculative knowledge, it is ſufficient to underſtand geometry, but much experience is neceſſary to give ſatisfactory inſtructions on the practical part; and though the number of engineers, capable of doing this, were

equal to that of other learned men, their employment, which confines them to the frontier towns, and finds them almoſt conſtant work, allows them little time to range their ideas in order, much leſs the means of giving them to the public.

YET the ſpeculative theory, being only a means by which we may arrive, by the ſhorteſt and ſureſt road, to the practical, and of all military enployments, ours being ſubject to the greateſt variety, one may judge of what importance that aſſiſtance is, which we almoſt entirely want.

I SAY almoſt entirely, and a little conſideration on the knowledge of this kind neceſſary for an engineer, will convince every one, that the expreſſion is not improper.

THIS knowledge conſiſts in the fortification, conſtruction, or the art of executing a project with proper ſolidity and œconomy, the attac and defence of places, and what regards field-engineering.

I include fortification, tho' I am not inſenſible it has its ſpeculative theory, that is, principles, or rather maxims, which ſerve for rules; the ſame may be ſaid of the attac and defence of places, which are neceſſarily connected with thoſe maxims. Beſides, thoſe maxims are not capable of demonſtration; and they are ſo dependant on the ſituation, &c. of the ground, and other phyſical circumſtances, that not judging them fit to be ranked among ſciences purely ſpeculative, I thought I might place them in this claſs.

ALL the different parts of engineering being relative to fortification, which is without doubt the principal; the different parts of this knowledge tending almoſt entirely to fortification.

IF the number of books could ſupply their quality, we certainly could deſire no more upon this ſubject? Moſt authors have thought to reform the whole on new ideas, by improperly changing the inclination of one line; others, to diſtinguiſh themſelves more, have imagined

gined the moſt monſtrous figures, induced thereto by the eaſineſs of the performance.

WRITERS of all degrees and profeſſions, even thoſe moſt incompatible with arms, have preſcribed methods and rules, and this jumble of uſeleſs pieces have been honoured with the name of ſyſtem *.

I know that among the number of authors, there have been engineers of eſtabliſhed and reſpectable characters, ſuch as *de Ville*, *Count de Pagan*, and *Baron Coehorn*; I am far from confounding them with the others, but it is evident their deſign in writing was leſs to inform pupils, than to attain ſome ideas, either new, or eſſentially differing but little from what was already known, and approved by connoiſſeurs.

WE cannot be ſurpriſed that in the vaſt number of books, there are not, perhaps, four worth reading on this ſubject, and not one in which are found all the neceſſary inſtructions which might be contained in a treatiſe of a moderate ſize.

CONSTRUCTION is an art which includes ſuch different objects, and depends on ſo many circumſtances, that few authors have treated of it, and none in a manner ſufficiently inſtructive, or extenſive: we have nothing compleat in this kind. An engineer is often obliged, for his inſtruction in this important affair, to his own miſtakes, which are always attended with uſeleſs expence.

WE are much more fortunate in regard to the attac of places: *Vauban* who invented, rather than perfected this art, has wrote on it as extenſively, as ſolidly: ſince that valuable manuſcript has been printed in *Holland*, there is nothing eſſential to be wiſhed for on that head.

* *Montecuculi* was of the ſame opinion; he ſays, in B. I. Chap. 5. "But how many different combinations may be made of the reci-
"procal proportions of thoſe parts? How many have treated of
"them? How different are their diſcoveries? They are infinite and
"tireſome in thoſe who have been only compilers, or copied one
"another, or have only chimerical ideas without practice.—It is a
"*proteus*, changing into a thouſand different forms."

That great man, in 1706, wrote on the defence of places: nothing indifferent can come from ſo maſterly a hand, the work is worthy the reputation of the author; but our conqueſts, continuing almoſt without interruption, not having given him an opportunity of exerciſing his talents on this ſubject, as on the other, and it being an object which conſiſts chiefly in chicanery, or ſtratagem, and therefore ſubject to much more variety, it is thought that nothing can be retrenched from the work, but much may be added to it.

Besides this manuſcript (for I am not talking of what is publiſhed at the end of the attac) is ſo ſcarce, that there is little probability of its being ſoon printed.

Tho' moſt of thoſe, who have wrote on fortification, have treated on that part which concerns the field, I may, without exaggeration, aſſert they have ſaid nothing to the purpoſe.

What does it ſignify, in treating of ſuch a ſubject, to give a plan and profil of lines in ordinary ground, to ſhew how to raiſe a redout, or flank a piece a little more extenſive, often contrary to the rules of reaſon.

This kind of forgetfulneſs has proceeded from different cauſes; cabinet authors, to whom the combination of a few angles and lines, gave room to diſplay their ſkill in fortifying places, not being able to treat of this ſubject, founded almoſt entirely on practice, by taking the moſt prudent part, have abandoned it to its profeſſors.

The conqueſts of a reign, for a long time happy, were not circumſtances proper for perfecting an art, whoſe principal object is a defenſive war. It muſt alſo be obſerved, that a brigade of engineers was then thought ſufficient for an army, this brigade conſiſting only of ſix, and they generally employed.

Thus our ſucceſſes were an obſtacle to our inſtruction; and it is not ſurpriſing, that in the ſmall number that afterwards had an opportunity of improving, the talent of arrangeing and expreſſing their ideas, or an inclination

inclination to publiſh them, have not been found united with the neceſſary leiſure and experience.

After ſhewing in what we are deficient, I may be allowed to offer a remedy.

Though fortification of places, important as it is in itſelf, and in its connection with the other parts of this knowledge, is, to ſpeak in general, that to which engineers leaſt apply.

This indifference probably proceeded from their having learned it by rote, without principles, which a maſter little ſkilled in the art renders reſpectable by the name of the author, from whom he borrows it; and which makes them conſider it as confined, or already carried to its utmoſt extent.

That a ſcience, ſo much neglected by thoſe whoſe intereſt it is to cultivate it, ſhould have employed ſo many, is a conſideration inſufficient to remove this prejudice, and I may venture to ſay, that the uninſtructive uniformity, or diſguſting whims of ſo many different productions can only confirm it, and give a diſtaſte to ſuch a ſtudy.

Ideas more extenſive, or more methodically ranged, learned at ſchool, or immediately after, would give more inſight, and a better taſte for a point ſo eſſential.

I could wiſh ſome perſon of capacity would begin, by explaining the different parts which form the front of a fortification; for example, to deſcribe a rampart, ditch, covert-way, explain their uſes, what ſhould be their heighth and breadth, the advantages attending their being encreaſed or diminiſhed; afterwards treat, with the ſame attention, of the whole incloſure, the different regular figures, and the outworks uſed to cover the body of the place; then ſhew how to draw a plan after the principal ſyſtems already known, examine them accurately, weigh their advantages and defects, and ſhew by the little difference among thoſe ſyſtems, the ſmall progreſs yet made in this art; then conclude by laying down

down general maxims, and ſhewing how they ſhould be applied to irregular figures.

I am convinced ſuch a work would produce very different ideas of fortification, from the preſent; and was it better known, it is probable would be more cultivated.

If practice be indiſpenſably neceſſary to form an engineer, it is principally in regard to conſtruction; and tho' I own this neceſſity, it cannot be denied that in this caſe, as well as others, ſome well wrote treatiſes would remove the greateſt difficulties. When perſonal experience is neceſſary, but for want of opportunity cannot be obtained, is it not a great advantage to be enabled to benefit by that of others?

How uſeful would a collection of inſtructions be, chiefly drawn from projects and ſchemes, and enriched with plans, profils, and deſigns of the different kinds of works, erected in *France*, ſince the eſtabliſhment of the body of engineers? I may aſſert that, not only young engineers, but others would be greatly improved from ſuch a work.

Suppose, for example, any one is directed to build a bridge over a precipice, or to conſtruct a ſluice, or a reſervoir on a conſiderable river, what better models could be followed, than what has been lately done at *Briancon* and *Mentz*.

All the neceſſary materials might be found in the engineer's, or public offices, and in the hands of the directors. The engineer charged with this important work ſhould draw all the plans, and arrange and unite the different parts, which ſhould be furniſhed by thoſe appointed for this undertaking.

Many excellent works now hid, or forgot, would be then exhibited, be of laſting and public utility, and ſave the crown vaſt ſums, daily laviſhed on defective, or ill conſtructed buildings.

It is evident, that I ſuppoſe the interpoſition of the government, but can there be any doubt of its aſſiſtance to carry ſo uſeful a project into execution.

Vauban's

Vauban's Memoirs, carefully compared with the original manuſcript, would be an excellent baſis for a compleat treatiſe on the attac of places.

I would have joined to it, by way of commentary, all the remarks and additions that ſhould be thought neceſſary. That author's firſt Memoirs, ſome printed books, the writers of the beſt engineers, and the moſt remarkable paſſages, taken from the journal of ſieges, would furniſh ample materials for ſuch a work.

The ſame method might be taken with that general's Memoirs on the Defence of Places, or, if thought neceſſary, it might be new modelled.

In diſtinguiſhing, as I have done, the attac and defence of places, from the functions of a field engineer, it appears at firſt ſight, that the difference is ſo little as ſcarcely to be perceived, but experience has convinced me of that error, and I have imagined, that without quitting the ſubject, materials may be found for a treatiſe, as full of variety, as new and inſtructive.

When we conſider, that of the five parts of practical theory, there is none, on which much more may not be ſaid, there is no avoiding our ſurprize at a neglect ſo prejudicial.

It is certain, that what concerns the conſtruction cannot be clearly treated of, but by a well judged collection of what the greateſt genius's have practiſed for ſeveral years paſt, which requires the aſſiſtance and authority of the government; but it might have been aſked, and it is evident the ſame excuſe cannot be alledged for the other parts.

In vain do we ſeem to expect from other hands that aſſiſtance, which our corps alone is capable of giving us: it muſt be an engineer that can write well on this ſubject, and I may venture to ſay, that being no leſs men of council than military, it is not more honourable than advantageous to us, to leave to ſtrangers the care of our inſtruction.

These conſiderations induce me to ſpeak by example; but proportioning my taſk to my leiſure and capacity,

city, or, perhaps, enclined by the novelty of the ſubject, I at preſent confine myſelf to the ordinary ſervices of the field, in which I have the advantage of ſome years recent experience.

As temporary, or field fortification, is the firſt and principal part of this ſervice, its theory ſhall be the ſubject of this Volume.

If it be well received, I may be induced to proceed, it ſhall ſoon be followed by a Treatiſe on Conſtruction; and to render it more compleat, I will add, as far as poſſible, all the neceſſary inſtructions, on the moſt minute works, and the different commiſſions, that an engineer may be charged with in the field: it is well known that this kind of conſtruction, quite different from that of permanent fortification, is neither leſs extenſive, or varied; and I may ſay, that I have little to ſeek for on this ſubject.

The inſtruction of our body being my chief motive, I ſhall gratefully receive any hints that may be given for the improvement of this Treatiſe, yet think it neceſſary to acquaint the reader of a point that requires his indulgence.

Which is, the neceſſity I am often under of ſpeaking of myſelf; I know that ſuch quotations, particularly when they regard ſciences, are ſeldom excuſed, they are generally ſuppoſed to be the over-flowings of ſelf love, which wounds one's ſelf, by arrogating a kind of ſuperiority. The caſe is therefore nice, but it ſhould be conſidered, that there being ſcarcely any thing wrote on this ſubject, that could furniſh me with examples, I have been obliged to quote what I have ſeen, and put in execution: that field fortification generally ſubſiſts but a ſhort time, and that rank in which I ſerved during the two laſt wars, qualified me for ſuch a diſtinction, that I have ſeen little of this kind, of which I had not the charge.

I hope theſe reaſons will juſtify me, at leaſt with the indulgent reader; as to the others, they may if they

pleaſe

pleaſe conſider what I have wrote, only as a relation, accompanied with reaſonings (and in a different order from their dates) of what I have ſeen or executed in this kind: however this error, if one, relative to the author only, will not diminiſh the utility of the book.

I have little more to add: my reaſon for putting a general Preface, before a particular Treatiſe; if I am ſuppoſed not to deſign writing ſucceſſively on the other parts, it muſt be allowed, that it may be of ſervice in exciting other engineers to it: ſuch a motive juſtifies the reſt; and if it produces ſo good an effect, may be more uſeful than this work.

CONTENTS.

CHAP. 1. I. *Field fortification.* II. *Its particular maxims.* III. *Defects of ſaliant angles.* IV. *Means of correcting them.* V. *Redouts, their moſt perfect figure.* VI. *Size and uſe.* — page 1.
Obſervations, — 11.

CHAP. 2. I. *Field forts in general.* II. *Star forts.* III. *Second flanks.* IV. *Triangular and ſquare forts.* V. *Heads of bridges.* VI. *Their figures according to different caſes.* VII. *Thoſe of a more durable conſtruction.* VIII. *Scheme of moving flanks.* IX. *Other uſes of armed boats.* — 14.
Obſervations, — — 25.

CHAP. 3. I. *Examples of the method of fortifying a church-yard.* II. *A church.* III. *An old caſtle.* IV. *A country-houſe.* V. *Attac of a country-houſe.* VI. *Inſtructions on the different ſubjects of this chapter.* 29.
Obſervations, — — 40.

CHAP. 4. I. *Fortifying ſmall towns and other conſiderable places.* II. *Advantages and diſadvantages in regard to the diſpoſition and conſtruction of the houſes.* III. *Inconvenience of their great extent.* IV. *Means of correcting it in certain caſes.* V. *Inconveniencies almoſt always inſurmountable.* VI. *Places to be intrenched for a day of battle.* VII. *Communications to be eſtabliſhed from a poſt to a bridge; firſt example.* VIII. *Second example.* — — 41.
Obſervations, — — 54.

CHAP. 5. I. *Intrenched camps; their uſe.* II. *Their poſition.* III. *Encampment of troops.* IV. *Intrenched camp of* Ruſſenheim; *firſt ſcheme.* V. *Second ſcheme, with reflections.* VI. *Enquiry into the interior of the firſt.* VII. *Third ſcheme.* VIII. *Defects of the firſt and third.* IX. *Intrenched camp of* Spire. 55.
Obſervations, — 67.

CHAP.

CHAP. 6. I. *Different uſes of lines.* II. *Objections and anſwers to thoſe that cover an army.* III. *Thoſe that cover a country.* IV. *Thoſe deſigned for a new ſyſtem of a defenſive war.* V. *Neceſſity of ſupporting the extremities of theſe lines, and how.* VI. *Diſtance of lines, from heads of camps.* VII. *Defects of common lines.* VIII. *Means of correcting them.* 69.
Obſervations, — — 80.

CHAP. 7. I. *New ſchemes of lines with redans.* II. *With tenailles.* III. *More perfect.* IV. *With indented works.* V. *With redans and lunettes, their inconveniency.* VI. *With tenailles and lunettes.* VII. *With broken tenailles and lunettes.* — 85.
Obſervations, — — 96

CHAP. 8. I. *Lines with baſtions after the common method; their defects.* II. *A new and more perfect method.* III. *Schemes of lines with detached baſtions.* IV. *With detached works.* V. *Lines detached in parts.* VI. *Works to be made for a day of battle.* VII. *Example of their uſe at the battle of* Fontenoy. VIII. *Lines joined to works cloſed at their gorge.* 100.
Fontenoy Battle, — 109, 110.
Obſervations, — 113.

CHAP. 9. I. *Advantages from a river, to cover lines.* II. *What may be done in flat ground, when under the fire of the intrenchment.* III. *When it is at a diſtance from the whole, or any part.* IV. *Inundations; where they may be made by ſingle dams.* V. *Thoſe made with ſluices; their inconveniencies.* VI. *A more perfect ſcheme.* VII. *Scheme for an inundation for lines that are to ſtand a long time.* VIII. *Multiplicity of dams; means of correcting them.* IX. *Dams too long; means of defending them.* X. *Recapitulation of all theſe defects.* XI. *A new method of forming inundations in flat ground, in any place.* — 118.
Obſervations, — — 131.

CHAP.

CHAP. 10. I. *Intrenchments to be made in caſe of a river.* II. *Plans of works to paſs it by open force.* III. *To repaſs it in the preſence of an enemy.* IV. *Another Scheme.* V. *Example of the camp at* Nordheim. VI. *Precautions to be taken to prevent the paſſage of rivers.* VII. *Remarks on* Folard's *epaulements.* VIII. *Continuation of theſe remarks, and ſchemes of the author.* IX. Folard's *ſchemes.* — 136.
Obſervations, — — 150.

CHAP. 11. I. *Gates.* II. *Communications.* III. *Platforms.* IV. *Epaulements for cavalry.* V. *Scheme of intrenched epaulements.* VI. *Bog-houſes.* VII. *Forms of covering the gates of common lines.* VIII. *Covering thoſe of the different kinds of lines propoſed.* IX. *Advanced ditches; their advantages.* X. *Ravelins.* 155.
Obſervations, — 166.

CHAP. 12. I. *Irregular fortification: maxims.* II. *Rentrant angles.* III. *Saliant angles.* IV. *Method of occupying heights, of preventing their being enfiladed, and tracing works on their deſcent.* V. *Reflections on heights.* VI. *Villages and buildings within reach of the work.* VII. *Caſe where detached works are neceſſary.* VIII. *Woods.* IX. *Moraſſes, hollows, hollow roads, hedges, rivulets.* X. *Manner of proportioning to the ground, the lengths of the fronts of the propoſed method.* — — 167.
Obſervations, — 179.

CHAP. 13. I. *Profils.* II. *Reflection and example.* III. *Defects of profils too much elevated.* IV. *Obſervations on the author's breaks.* V. *Height of parapet.* VI. *Their thickneſs.* VII. *Their pent or ſlope.* VIII. *Their interior height.* IX. *Banquets and their ſlopes.* X. *Ditches and advanced ditches.* XI. *Other ſlopes, and their berm.* XII. *Glacis and covert-way.* 180
Obſervations, — 192.

FIELD

FIELD ENGINEER.

CHAPTER THE FIRST.

I. *Field fortification.* II. *Its particular maxims.* III. *Defects of ſaliant angles.* IV. *Means of correcting them.* V. *Redoubts, their moſt perfect figure.* VI. *Size and uſe.*

I. THE art of fortifying, conſtructing, attacking and defending fortified places, comprehends the moſt eſſential and ſhining parts of an able engineer; there ever will be many unforeſeen incidents to learn in the field; they ſhould have good draftſmen, as aids de camps, to make actual ſurveys of the adjacent countries, by which they ſhould know the advantage, &c. of every part of their ſituation; his genius ſhould be unconfined, he ſhould poſſeſs all the requiſites of a great commander, and a commander, all that of the engineer, partiſan, &c. with the bravery of Alexander, and the wiſdom of Cæſar.

An army, judiciouſly intrenched, produces, in many reſpects, the ſame effect as a fortreſs; it covers a country, ſupplies the want of numbers, ſtops a ſuperior enemy, or obliges him to engage at a diſadvantage.

On the other hand, being maſter of the field, there are poſts, heads of bridges, quarters to ſecure, and many other works to conſtruct.

The knowledge of a field-engineer being founded on

the principles of fortification, it muſt be allowed, that the art of fortifying is as neceſſary to an army in the field, as in fortified places; though the maxims are the ſame in both, yet the manner of applying and executing them with judgment, is very different.

A project of fortification is commonly the reſult of a long meditation; the engineer plans, digeſts, and examines it in his cloſet; compares at leiſure his different ideas, and, provided the work be ſolid and durable, he is not anxious about time, materials, or any other neceſſary means, which he knows are to be had in the execution. In the field it is otherwiſe, no regard is to be had to the ſolidity of the works; every thing muſt be determined on the ſpot; the works are to be traced out directly, and regulated by the time, and number of workmen, depending on no other materials than what are at hand, or no other tools than the ſpade, ſhovel, pic-ax, and hatchet.

It is therefore in the field, more than any where, that an engineer ſhould readily know how to ſeize on all advantages at ſight, to be fertile in expedients, inexhauſtible in invention, and indefatigably active. Vivacity and fertility of genius, which are natural talents, are inſufficient, without the knowledge acquired by practice. To contribute to this knowledge as much as poſſible is the deſign of this work.

II. To begin, I ſhall add to thoſe general maxims of fortification, which the reader is ſuppoſed to be acquainted with.

Iſt. To incloſe within the work as much ground as poſſible, having regard to circumſtances. This attention, which principally concerns redouts and ſmall forts, is neceſſary for the guards of theſe works, to lodge and to move commodiouſly; on the other hand, that the troops may be leſs crowded in their camp, or different motions.

IIdly, If there are ſeveral works near each other, that their lines of defence are ſo directed, that they may defend

defend each other, without annoying themſelves by their own fire. The utility of the one, and the inconveniency of the other of theſe obſervations, are too evident to need an explanation.

IIIdly, Not to depend on the defence of ſmall arms, but where the ſoldiers can fire at right angles; becauſe they generally fire without aim, and directly before them.

IVthly, Not to have recourſe to the ſecond flank, or fire of the curtain, but when there is an abſolute neceſſity. This maxim is a conſequence of the former; it will appear beſides, in article III. of the next chapter; that the real defence is not to be eſtimated by the length of the oblique flank, but by that of the perpendicular, let fall from its extremity on the line of defence.

Vthly, That the flanking angle, that is, the angle which the flank forms with the line of defence, be always a right one, or more obtuſe, but never to exceed 100 degrees, if poſſible; becauſe there is no fear here, as in a fortreſs, that the flank be too much expoſed. Beſides, it is not neceſſary to graze the faces, or even to fire obliquely on them; ſince there is no danger of being expoſed to the defence of a breach, or lodgement of the miners. The only thing to apprehend, is a ſudden attac, commonly in column, by a ſuperior enemy, difficult to reſiſt, if once got over the ditch; it is therefore neceſſary to ſtop him at ſome diſtance, to diſcourage him, and not to increaſe our own danger, by expoſing us without neceſſity to our own fire; which unavoidably happens, if the flanking angle be acute; becauſe in theſe moments of confuſion, the fire is always badly directed; yet, at the ſame time, the oppoſite extreme ſhould be avoided, not to make the angle too obtuſe; for in this caſe, the fire does not ſo well defend the ditch; it ſpreads too much, and does not croſs, or very little, before the ſaliant angle; for theſe reaſons, rather than the deſire to lengthen the flank, I prefer, when convenient, the angle of 100 degrees, to a right one.

VIthly, That the flanking parts be ſufficiently extended, ſo that the interior of their parapets at leaſt rake the whole breadth of the oppoſite ditch. When the enemy is near, eſpecially in column, a front fire ſeldom ſtops them; as the enemy is under cover, when in the ditch, from all other fire but that of the oppoſite flank, which therefore ſhould be as long as poſſible.

VIIthly, Never to make an advanced ditch in dry ground, unleſs it may be enfiladed throughout, and under a proper angle, to be defended by the work which it covers or ſurrounds.

Works, without flanks, ſuch as redouts, and thoſe whoſe flanks are too oblique, or not ſufficiently extended, are the only which ſhould not have advanced ditches *.

VIIIthly, Not to allow more than from 60 to 80 fathoms for the lines of defence, when they proceed from two flanks ſeparated by two branches, which form a ſaliant angle, or when not made to croſs tho' produced.

As the flanked angle of polygons, deſigned by the firſt caſe, are the parts moſt expoſed, they cannot be too well ſupported; the ſecond particularly concerns † indented works, where the defences being parallel, and directed the ſame way, cannot croſs each other, the fire of one flank ought to be doubled by that which precedes it; as may be ſeen in the article of lines.

IXthly, That the parts moſt extended, and conſequently the weakeſt, be as much defended as poſſible, and have at leaſt the fire of two flanks, beſides their own direct fire. Nothing can be plainer, than to defend that which wants it moſt.

III. All fortifications, ſuppoſe either a plane figure or a line only, that are or may be put into a ſtate of

* We have omitted a great part of this paragraph, as being of no uſe to explain the reſt.

† *Cremailleres*, is rendered in Engliſh *indented*, as meaning the ſame thing, viz. like the teeth of a ſaw, as in plate I. figure 4. where the covert way is indented.

defence. A line is not eſteemed fortified, but as it is flanked; fortification therefore neceſſarily ſuppoſes angles, and conſequently ſaliant.

If the ſaliant angles are formed by right lines, they have the advantage above others, of being defended and grazed in all parts: this muſt be evident to every one, yet, in my opinion, their defects have not been minutely conſidered. The ſoldier generally fires mechanically, and conſequently right before him; experience has ſo often convinced us of this, that it may be laid down as an axiom. It follows then, that at the point of each ſaliant angle, there is a conſiderable ſpace which is not raked by any direct fire; for I look on one man that may be placed there, as nothing. That ſpace is a circular ſector, terminated by the ſides of the angle produced, and the radius, the utmoſt range of a muſket ſhot; ſo that, if this angle be a right one, and the muſket range 150 fathoms, there will be a ſpace of about 17679 ſquare fathoms, where the beſieger has no fire in front to fear. It is from this knowledge, oft very ſuperficial, that trenches are conducted, as much as poſſible, on the prolongation of the capital, and that ſkilful officers direct their march, as well for the attac of the covert way, as for that of any other work. Plate I. Fig. 1.

IV. To remedy this defect, ſome engineers round theſe angles, which, in effect, diſperſes the fire equally every where: this method is preferable to the common conſtruction; but the rounding being of little extent, for fear of leſſening the place of arms, or the work, the fire becomes very ſmall and ſcattering. Fig 2.

As it is the capital, which is moſt diſtant from the flanking parts that has moſt occaſion to be defended, I would rather chuſe to cut this angle off by a right line. Both theſe methods diminiſh the defect only; the following one remedies it effectually, and is eaſy in practice, at leaſt in fortified places. Fig. 3.

Fig. 4. Trace the interior part of the parapet, not in a right line, but indented, obſerving that one face of each redan be perpendicular, and the other parallel to the capital; a conſtruction that ſeems the moſt advantageous, as two or three different defences are drawn from the ſame part.

It is not at all ſurprizing, that men of genius oft hit upon the ſame thing, M. *de la Fon*, director of fortification of the maritime places in *Flanders*, ſhewed me, in 1740 at *Dunkirk*, a project of this kind, in tracing a covert way: M. *de Verville*, formerly chief engineer at *Rocroi*, to whom I had not mentioned it, ſhewed me the plane of a ſquare redout, in 1741, then at the army upon the lower *Rhine*, wherein he had propoſed to defend the angles in this manner. So uſeful a diſcovery does theſe gentlemen honour, and I hope they will not be diſpleaſed at my mentioning their names.

V. A redout is the ſmalleſt piece of fortification that is conſtructed; I comprehend under this name every field-work, not flanked by itſelf; they are of two ſorts, one with a parapet, the other a * *Machicoulis*: this laſt is ſeldom uſed in the field, yet I have ſeen one in 1734, at a line of *Etelingen*; it was an exagon of timber-work, which ſerved for an intrenchment, and guard-houſe to a more conſiderable work. Redouts with parapets are more frequently uſed; they ſerve in the defence, and ſometimes in the attac of places, and frequently in that kind of war, we are here treating of.

When there is no eſſential reaſon to the contrary, their form is commonly ſquare, obſerving to oppoſe one or more ſides to the places to be commanded. If the redout is within reach of ſome other works, ſuch as a covert way, or lines, its faces muſt be turned ſo, as to

* *Machicoulis*, an old word, ſtill applied to projections in old caſtles, and over gates of towns, left open above, to throw down ſtones, &c. but it is not eaſy to underſtand the author's meaning in applying this word to forts; nor do I think it material to underſtand it, in the ſequel of this work.

be

be defended by theſe works. It is eſſential in this caſe, to join all together by a communication; beſides the aſſiſtance and a ſecure retreat, obtained by this diſpoſition, it has the advantage of not being attacked in the rear, but with great difficulty.

A communication, well made, may beſides give right and left flanks to thoſe parts by which the work is protected, as in chapter VII. It has been obſerved, how neceſſary it is to remedy the defects of ſaliant angles in general, in regard to redouts, it is not only uſeful, but neceſſary.

From what has been ſaid on this ſubject, we may conclude, that the ſurface which the piece rakes, or fires on, is to that which it does not, as the interior of the polygon, multiplied by the range of muſket ſhot is, to the ſuperficies of a circle, whoſe radius is the length of the ſhot; ſo that, ſuppoſing this range of ſhot always to be 150 fathoms, there is about a redout of 40 fathoms interior parapet, a ſpace of 6000 ſquare fathoms expoſed to its fire, and a little more than 70714 that are not.

As this rule is general, and the number of ſides makes no difference, it may be thought that a circle has not more advantages than another figure; becauſe it is only a polygon of an infinite number of ſides: this demands examination.

Though the ſpace a ball paſſes through has no greater breadth than its diameter, yet as each man that fires takes up 2 feet in front, I ſhall ſuppoſe it ſufficient to fire on a breadth of 2 feet.

If the redout has 40 fathoms interior circumference, its fire will form 120 parallellograms, which touching each other by the extremities of the ſmall ſides, leaving between the great 120 ſectors, which together form, as in the ſquare, a circle of 150 fathoms radius.

Conſequently, a circle may not only be conſidered as a polygon of an infinite number of ſides, but as one of 120 only.

I agree to theſe facts, which prove the rule I laid down extends to circular figures; yet I am convinced, that this figure, is preferable to the rectilineal.

In the ſquare, for example, there are only 4 ſpaces which are not defended; each of them contain right angles, and conſequently, near 17679 ſquare fathoms; whereas, by this ſuppoſion, I have in fact 120 ſpaces not defended, but each is leſs than 590 fathoms ſuperficies, and drawn from an angle of 3 degrees only*.

Great as this advantage may be, there is one much more conſiderable, viz. all the points of the circumference of a circle, being equally diſpoſed, the ſoldier poſts himſelf indifferently throughout; which makes the ſpaces defended vary every moment, and the enemy is ſecured in no particular part.

We may certainly conclude, that the round redout, tho' little uſed, is the moſt perfect we can form; that the fewer ſides theſe works have, the more defective they are; and that the contents of the ſpaces not commanded being the ſame in all caſes imaginable, the larger they are, the leſs this diſadvantage is in proportion.

The circular figures, though preferable, cannot be uſed but on certain occaſions; if, for example, it be required to fire on an object of ſmall extent, certainly a front muſt be oppoſed, whoſe fires will be parallel to each other; other circumſtances require a mixt figure, but in all theſe caſes, regard muſt be had to the defects of the angles.

Plate II. The infallible method is, certainly, that which we quoted at the end of the preceding article: the defect not only diſappears by that ingenious means, but that part becomes yet ſtronger than the ſide itſelf, as the extent of its defence is equal to that of

* As 120 ſpaces, of 590 ſquare fathoms, make 70800 fathoms, which is above four times the ſpace 17679; and therefore the circular figure is leſs advantageous in that reſpect, than the ſquare; theſe ſpaces are more equally divided all round, than in the ſquare, whereby one defect is in a manner recompenſed by another advantage.

the

the diagonal; yet, as the face of the redan ſhould not be much more than 3 feet, it appears difficult to execute it without ſome ſort of revetement, which we have ſeldom time, or means to make in the field.

We then ſhall oft find it neceſſary either to cut off the angle, or round it; if the latter, the rounding ſhould be as large as poſſible; and it muſt be farther obſerved, that the flatter it is, the more it will throw the fire towards the capital.

VI. The ſize of the redout is ſometimes determined by the nature of the ground, but generally by the number of men deſtined for its defence.

A parapet is well lined with two men to every fathom; this knowledge is neceſſary, but not ſufficient to determine the ſubject of this article.

40 men, for example, cannot, becauſe of the banquet, be contained in the *Terreplein* of a ſquare redout of 5 fathoms interior parapet for each face, and 160 will be too many for that of 20 fathoms in each ſide; becauſe in ſimilar figures, that, whoſe ſide is 4 times leſs than another, has 16 times leſs contents.

Hence regard muſt be had to the extent of the circumference, and to the ſurface at the ſame time.

A redout of 24 fathoms parapet, that is, if it is a ſquare of 6 fathoms interior parapet in each ſide, is the leaſt that ſhould be uſed.

On the contrary, they ſhould not exceed 64 fathoms, that is, 16 in each ſide; for as theſe pieces have no flanks, it is better, when we would have a work of a conſiderable extent, to throw up little forts, which I ſhall treat of hereafter. A remark, which probably eſcaped the notice of the engineer, charged with the conſtruction of the lines of *Etilingen*; for towards the extremity of the left, where we forced them, I ſaw a redout of about 40 fathoms each ſide: in this gigantic piece was, that *Machicoulis* of timber, which I have already mentioned.

A re-

A redout of 24 fathoms interior parapet will contain 36 men, and they are ſufficient for its defence: that of 64 fathoms will not be crowded, and will be lined 2 deep with 256 men. But the numbers of 36 and 256 are the ſquare of 6 and 16, that is, the 4th part of the extent of theſe pieces; we may then conclude, that if we quadruple the ſquare root of the number of men, which may be deſtined for ſuch works, it will give the extent of the circumference in fathoms.

If, on the contrary, the number of men a redout can contain be required, ſquare the 4th part of the fathoms of its extent or circumference, and the product is the number.

For example, what dimenſions ſhould be given for 100 men? Multiply 10, the ſquare root of a 100, by 4, it will give 40 fathoms for the extent of the parapets on all ſides: on the contrary, multiply 10, the 4th of the extent, by itſelf, the product of 100 is the number.

Large redouts, by this rule, contain, in proportion, more than the ſmall; but this muſt be an advantage; ſince they are not conſtructed, but in places of importance, or thoſe moſt expoſed, and, if neceſſary, the number may be diminiſhed. This method is ſufficient in practice for figures from 24 to 64 fathoms parapet; but it muſt be remembered, that the extent being equal, that which has moſt ſides can contain the moſt.

The uſe of redouts in the field, is commonly to ſecure a poſt, a grand guard, or communication; to defend a defile, a bridge, or a ford; they may be uſeful alſo in flanking lines, as hereafter.

In ſome caſes they may be neceſſary, to keep the enemy at a diſtance from ſome conſiderable poſt. In 1734, after the taking of *Philipſbourg*, we ſcarcely dared to graze our horſes 100 fathoms from the palliſades; the huſſars carried off, and killed an officer at the very foot of the *Glacis*, and the Imperialiſts, maſters of that ſide of the *Rhine*, marched in broad day, and paſſed their baggage over the capuchin-hill within cannon-ſhot of the place.

When

When I had repaired 2 old redouts on the ſide of the hill, and conſtructed a third; the huſſars diſappeared, we kept our paſture, and they marched off through the wood.

Observations on the firſt Chapter.

The author, conſidering that engineers ſtudy chiefly the manner of building, attacking, and defending fortified places, and that the knowledge required in the field during a campaign, for the uſe and ſecurity of an army, has been much neglected, though not ſo ſhining, yet as uſeful as the attac and defence; for which reaſon he has publiſhed this work, as the reſult of a long experience and theory, built upon the moſt unexceptionable principles.

He begins with adding ſeveral maxims or general precepts, to thoſe commonly laid down by writers upon fortification; and endeavours to correct ſome defects ariſing from the uſual conſtruction of their ſeveral parts: one of the moſt conſiderable is, that all ſaliant angles have no direct defence, whereby the approaches are always made in the direction of their capitals, as being the leaſt dangerous; to prevent which, and render that part as ſtrong as any other, he makes the faces AB, CB not in ſtrait lines as the cuſtom is, but indented as the face AB, in the following manner; draw AC and BD perpendicular to it; divide AB into any number of equal parts, and thro' theſe points of diviſions draw lines parallel to AD and DB: theſe lines meeting each other at right angles, will form as many flanks to defend the angle B as are equal to AD; and therefore the angle B will be defended by a flank equal to AC, in the direction of the capital DB, and each face AB will be defended in the direction DA, by a flank equal to the perpendicular BD. Plate A. Fig. I.

The author obſerves, that the parts parallel to AD, ſhould generally have not above 3 feet, as being ſufficient

cient to place 1 man; it would be a difficult matter to ſupport the earth on the inſide without a brick wall, which is ſeldom to be done in the field; but as ſods will anſwer the purpoſe full as well as bricks, in works of a ſhort duration, this objection is immaterial.

As each face parallel to AD is to its flank as AD is to DB; their proportion ſeems to be limited when the angle B is given, which in ſome caſes may be inconvenient; this may be obviated by drawing a line BE; and making the flanks on the ſide BC, parallel to that line; then they will be to their faces as BE is to DE; and the total defence of the angle B will be to the defence of BC, in a direction perpendicular to BE as twice DE is to BE.

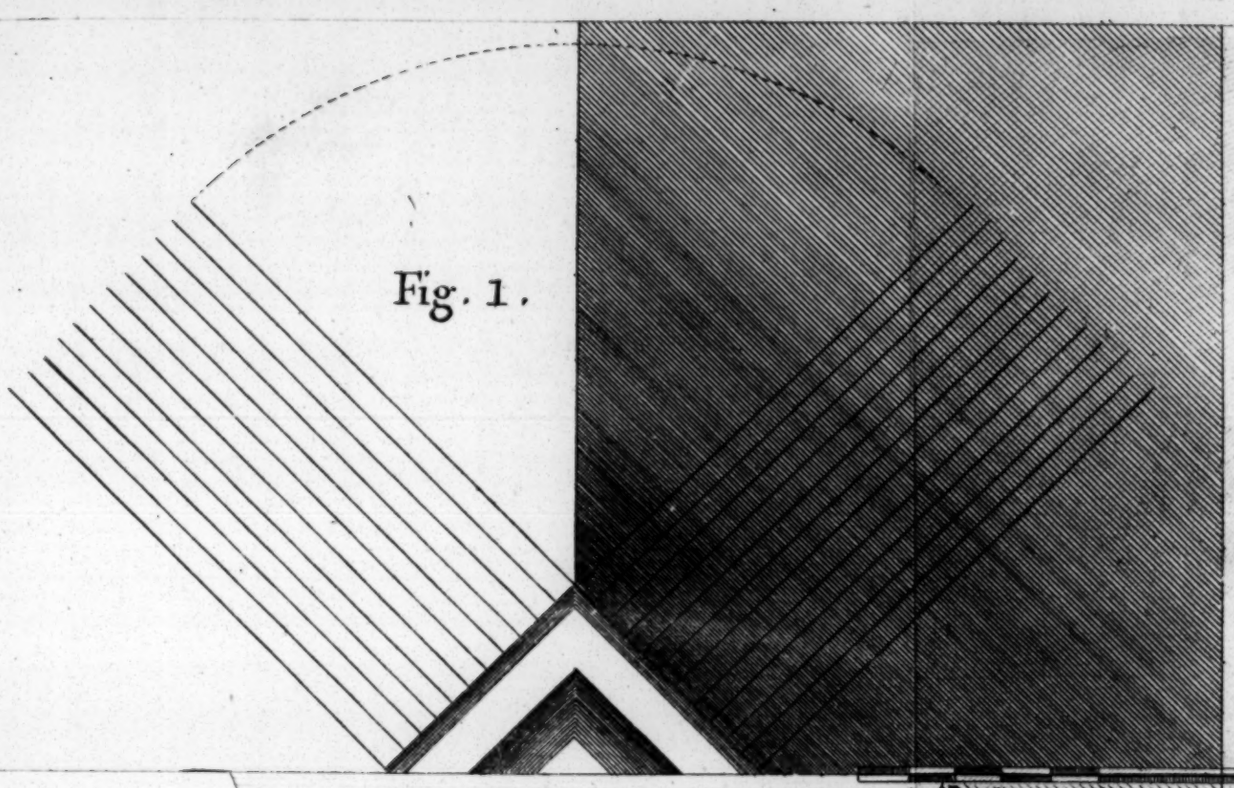
If the parapet of the covert way was thus indented, and the face 8, 10, or 12 feet, and the flanks twice that length, without any traverſes, the defence would be better than when they are made in the uſual manner; and then the covert way need be no more than 5 fathoms broad. When there are no traverſes, the enemy would find no ſhelter when he has taken it, the troops placed in the redans could not be diſturbed by the ricochet firing, and the motions would be more convenient. A piece of cannon might be placed in each redan, and thereby render the approach more dangerous. It is not cuſtomary to place cannon in the covert way; but, as it is the firſt work attacked, cannon placed there can defend it much better than from the baſtions, by a grazing fire, and keep off the enemy at a greater diſtance, till ſuch time that the covert way is in danger of being taken; they may then be removed to the inner works: the preſent practice of the moſt experienced engineers is, to make the capital works as low as poſſible, to prevent them from being ſeen from the ſame batteries as the outworks; cannons in the covert way are in this caſe abſolutely neceſſary.

Some engineers turn the ſaliant angles into a circular arch, in order to get ſome direct fire, but as only one

gun

SAILA

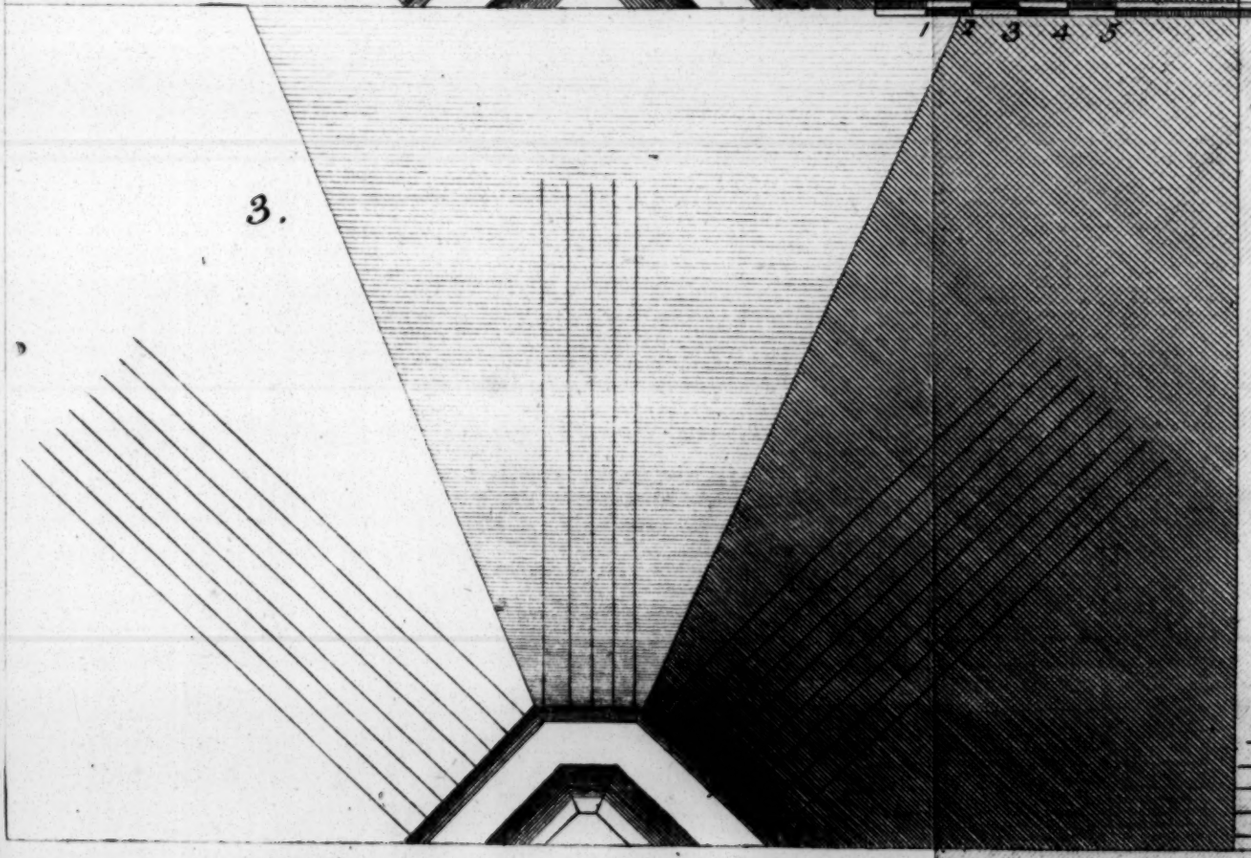
Fig. 1.



2.



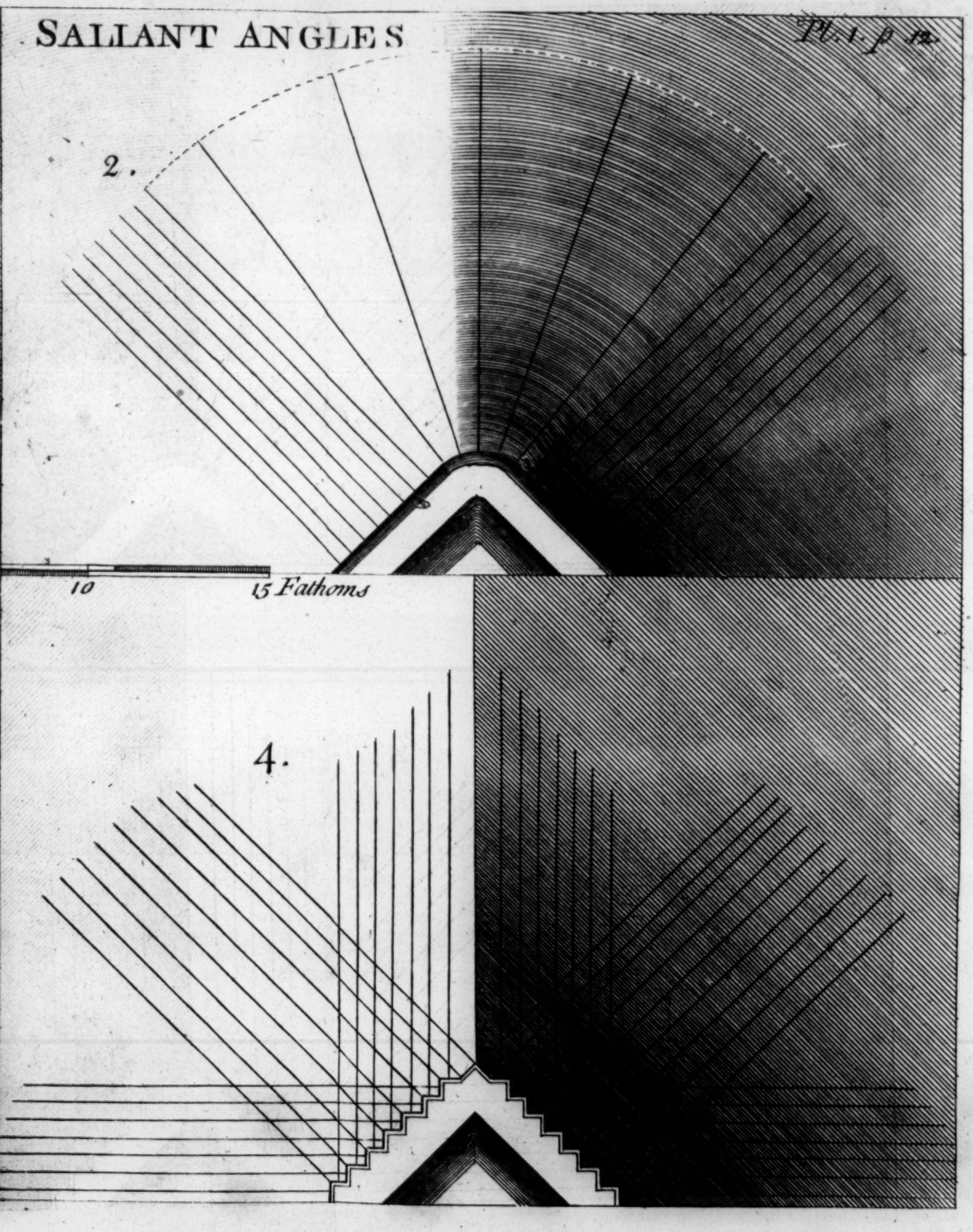
3.





SALIANT ANGLES

Pl. 1. f. 12.



gun can be placed there, this practice remedies the defect but little; the author thinks it would be better to terminate it by a right line; but even this is insufficient without forming the parapet as described above.

In all square or triangular redouts, without bastions, the saliant angles cannot be defended from any part whatever, when their sides are right lines, and therefore are very defective, unless one of the fronts serves to defend some particular pass, and the ditch can be filled with water; for which reason, our author recommends the circular form, as preferable, though not hitherto used; because every part is equally defended. In either case, the slope of the parapet should be as great as possible, without weakening it too much, the overplus of the earth, taken out of the ditch, should be laid on the outside in a glacis, to make the fire from the parapet more grazing; and when the ditch is dry, a row of palisades must be placed in the middle, and the parapet fraized.

The size of a redout is commonly determined by the figure of the ground, and number of men to defend it. It is supposed, that every man takes up 3 feet of ground; upon this supposition, it is easy to find the number of men to defend a work, placed 2 or 3 deep, from the length of the parapet at the inside. But our author observes, that this supposition is not just; because greater squares contain more room than small, in proportion to the squares of their sides; therefore the number of men should be proportional.

The author supposes 36 men sufficient to defend a square redout, whose interior side of the parapet is 6 fathoms; from whence follow these general rules. I. To find the number of men to defend a square redoubt without bastions; square the side expressed in fathoms, which gives the number of men required. Thus, if the inside is 12 fathoms, whose square 144 is the number of men required. II. The number of men to defend a redoubt being given, to find the side; extract

tract the ſquare root of the number of men, and you will have the interior ſide expreſſed in fathoms. Thus, if the number of men is 100, then the ſquare root 10 will be the number of fathoms required.

If the number of men is not a perfect ſquare, take the neareſt root under that number. Theſe rules are ſufficiently exact in moſt caſes; but as circumſtances vary, regard muſt be had to the importance of the poſt, and to the number of men an enemy may bring againſt it. It is not always ſufficient, to line the parapet 2 or 3 men deep, but there muſt alſo be a reſerve at hand, to replace thoſe that are killed or wounded. It is therefore the duty of the commander, to regulate the number of men as he judges neceſſary.

CHAPTER THE SECOND.

I. *Field forts in general.* II. *Star forts.* III. *Second flanks.* IV. *Triangular and ſquare forts.* V. *Heads of bridges.* VI. *Their figures according to different caſes.* VII. *Thoſe of a more durable conſtruction.* VIII. *Scheme of moving flanks.* IX. *Other uſes of armed boats.*

I. SMALL, or field forts, have the advantage of redouts, in being flanked, and the diſadvantage in containing leſs within, in proportion to their extent.

We may conſider them of 2 kinds: the 1 defending itſelf on all ſides, is entirely ſurrounded, and what properly falls under this name; the others, bordering on a river, precipice, &c. remain open at the gorge.

Some cabinet authors, for want of experience, have given pitiful deſigns on this ſubject, and ſometimes engineers fall into groſs errors, in the tracing them, for want of due attention.

Theſe forts, as the reſt, are regulated by the general maxims and principles I have given; obſerving in conſequence

ſequence of thoſe maxims, never to conſtruct a fort, under a certain ſize: it is better in that caſe to erect a redout, to preſerve more capacity.

The ſize, and conſtruction of theſe works differ, according to the manner in which they are to be fortified.

II. The moſt ſimple is, to * brake the lines in rentrant angles, which gives oblique flanks, without ſhoulders.

By the general maxims I have eſtabliſhed, we ſhall find, that the obliquity of theſe flanks, tho' oft great, is only more or leſs defective as it exceeds the angle of 100 degrees; and no regard ſhould be had to the dead, or rentrant angles which they form.

Theſe are called ſtar redouts, becauſe they reſemble that figure; *Adam Fritach*, who, on this ſubject, quotes the ſiege of *Breda*, ſays, they are commonly made of 4 angles, ſometimes 5, and very rarely of 6.

He conſtructs them by giving in the ſquare 1 eighth, and in the pentagon 1 ſixth of the length of the ſide, to the perpendicular which forms the brake. Plate III. Fig 1, 2.

The flanking angle in 1, is thus 152 degrees nearly, and more than 143 in the other: as they cannot be cloſed much more, no great protection muſt be expected from theſe flanks; yet the fire, croſſing at a ſmall diſtance, the polygon is certainly better defended, than by a right line; but the ſaliant angles, eſpecially in the ſquare, are too much expoſed.

I do not mention the difficulty of tracing a pentagon in the field without inſtruments, as every engineer ſhould have always a needle by him, which is ſufficient for that purpoſe.

Fritach ſays nothing of the conſtruction of ſtars of 6 angles: *Father Dechales* Plate III. Fig. 3.

* To brake a line, is to make it with 1 or more angles, either ſaliant or rentrant; the line ſerving for the baſe. See the notes at the end of this chapter, where all the conſtructions in this chapter are fully explained.

forms

forms them of equilateral triangles; this figure is regular, and I believe the moſt perfect of its kind.

The flanking angle being thus 120 degrees, the fires croſs better and nearer, and as the 2 flanks are on the ſame line, the ſpace, not defended before the ſaliant angle, is reduced to a parallelogram, whoſe ſmalleſt ſide is equal to the gorge.

Plate IV. Fig. 4. We may rank with theſe, ſtars of 8 points, which this eccleſiaſtic calls a ſquare; it is in effect a ſquare, where one third part of the ſide ſerves as a baſe to an equilateral triangle, which flanks the reſt.

This figure, though irregular, has the advantage of the preceding, in containing more ſpace, and croſſing its fires on the 4 right angles: as to the redans, the breadth of the ſpace not defended, is as in the other, perpendicular and equal to the gorge.

Theſe different figures compared, we ſhall find, that the defence increaſes, as well in front, as on the ſaliant angles, in proportion to the number of ſides; therefore, contrary to the opinion of the *Dutch* author, the ſtar of 6 points is preferable to that which has leſs, and that of 8 points preferable to that of 6.

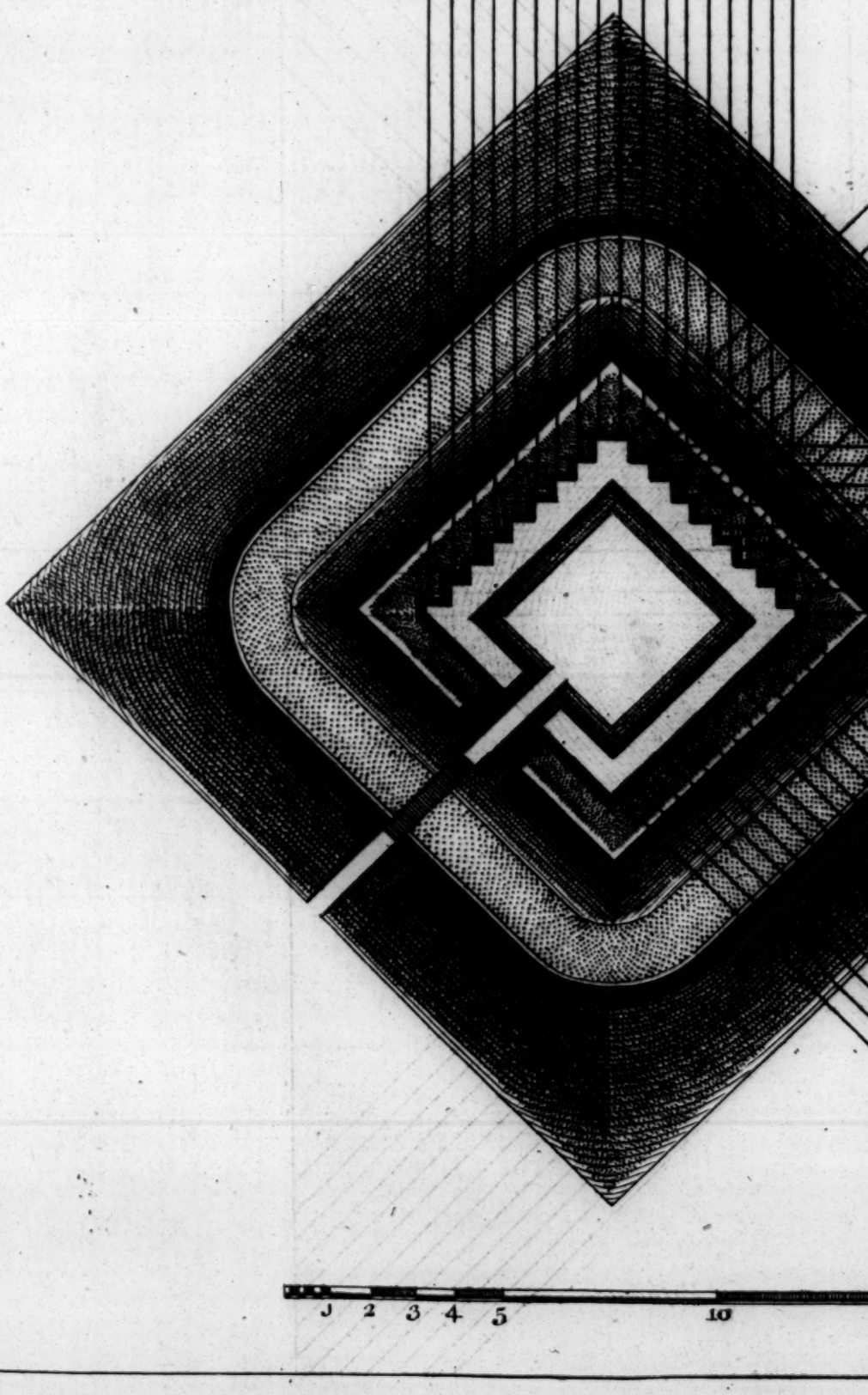
Their moſt perfect conſtruction is, to form on each ſide of an octagon, an equilateral triangle. The figure is regular, its flanked angles are 60 degrees, and its flanking 105, which is not too much; but, as it is difficult to trace this on the ground, the following comes very near it.

Biſcet the ſides of a ſquare, giving 1 eighth of the ſide to the perpendicular, as in the ſtar of 4 points, and elevate on each front an equilateral triangle, the 3d of 1 of the 8 ſides ſerving as a demi-gorge.

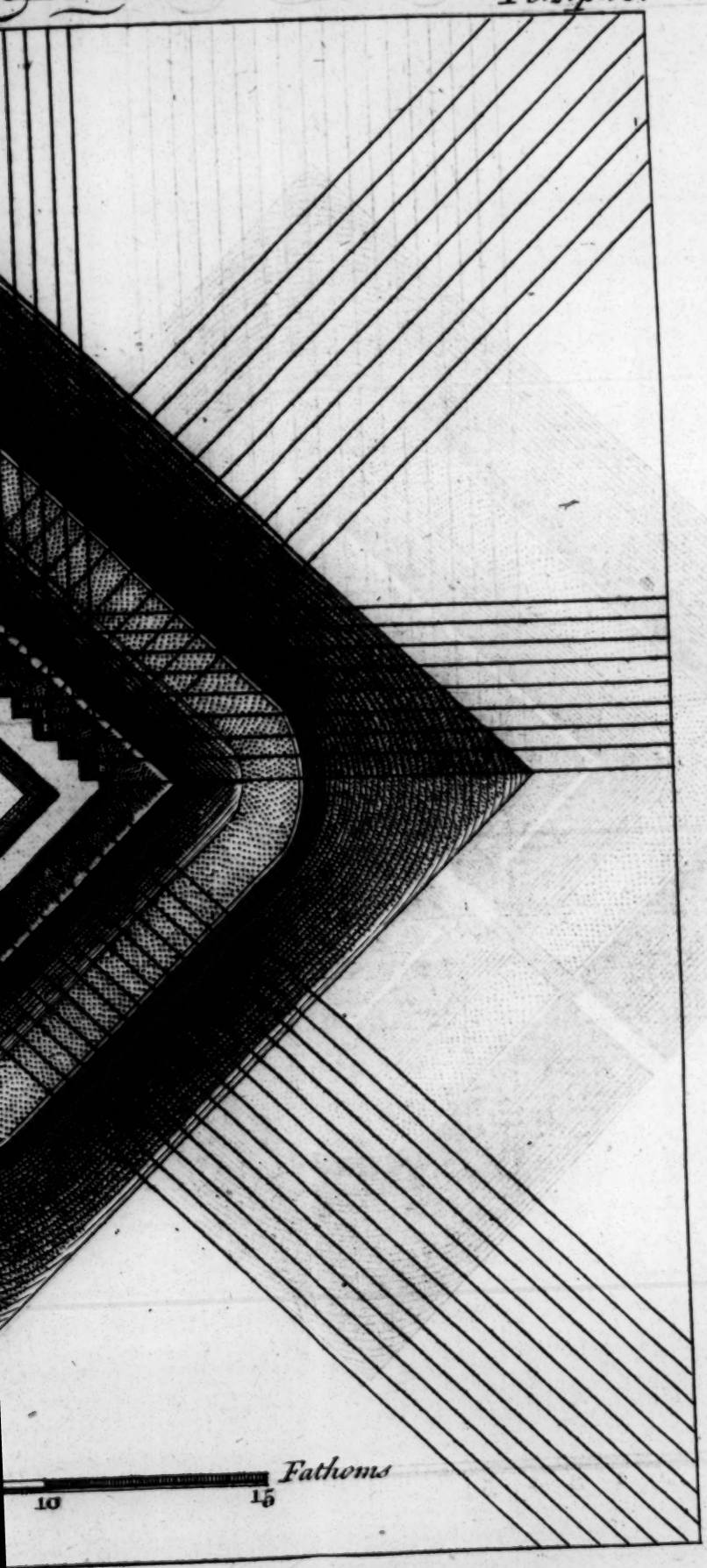
The flanked angles, by this, become alternatively 61 degrees 56 minutes, and 60 degrees; and the flanking angles 105 degrees 58 minutes. I executed this work with approbation in 1743 on the queich.

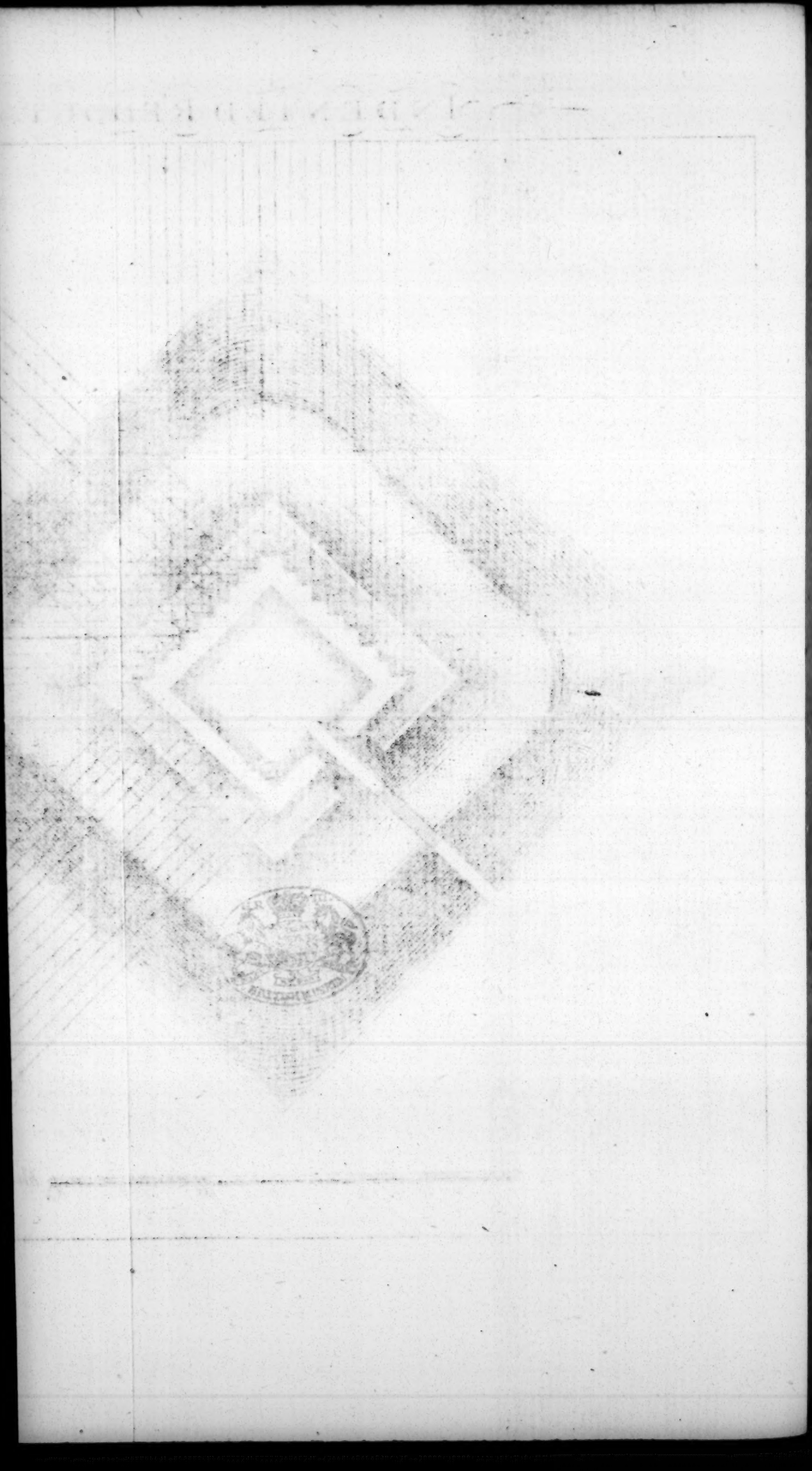
I think

INDENTED REDO



REDOUT. Pl.2. p.16.





I think they ſhould be limited to this number of points; it is very difficult to trace them, and beſides, uſeleſs to the defence, if they have any more.

III. The conſtruction of baſtioned forts, differs in nothing from that of places, except that the figure being ſmaller, and the attac ſuppoſed of another kind, it is reckoned ſufficient to flank them with half baſtions.

The face of half baſtions draw their only defence from what we call the 2d flank, that is, from 1 part of the curtain; on which we muſt make an eſſential obſervation.

I have ſhewn, that the ſoldier generally fires directly before him; though this is an important point, I will take no notice of it here, but ſuppoſe on the contrary, that he fires in the proper direction.

I ſhall not enquire into the advantages and diſadvantages of the 2d flank, ſo much eſteemed by the *Dutch*; ſuch a diſcuſſion, tho' neceſſary, in a general treatiſe on fortification, would be here unneceſſary; I ſhall confine myſelf therefore to the effect of this defence.

The approbation of many authors give room to think, that ſome of them ſuppoſe this defence to conſiſt in the length of this part of the curtain, inſtead of which, it is reduced to the length of a perpendicular, let fall from its extremity on the line of defence. Plate V. Fig. 1.

Suppoſe 2 or 3 feet interval between each muſket, the diſtance of a parallel to another being to be taken perpendicularly, it is evident, that the 2d flank will give no more fire than that perpendicular we have ſpoken of. That is, if the length of the 2d flank be 54 feet, and the flanking angle, as I ſuppoſe it in a triangular fort, 166 degrees 6 minutes, there will not be 13 feet real defence. The figure will better explain this than words.

IV. This 2d flank, which, after all, we are obliged to have recourſe to here, is ſmaller, and more oblique in the triangular figure than in the ſquare; the triangu-

lar figure contains leſs in proportion, which is a diſadvantage according to our maxims; for this reaſon, we avoid uſing them, if poſſible; yet as circumſtances ſometimes oblige us to it, the following is the beſt method of fortifying them.

Plate V. Fig. 2. Form an equilateral triangle, and divide the ſide into 3 equal parts; lay 1 of theſe on the prolongation of the ſide for the capital; draw the line of defence from this point to the extremity of the other ſide of the triangle; make the gorge equal to the capital, that is, to 1 third of the ſide; raiſe the flank perpendicular according to *Fritach*, or rather about 10 degrees more open, as in the plan annexed.

The ſquare is fortified the ſame way, except the angles of the polygon, being more open, in proportion to the number of ſides, the line of defence is drawn from the middle of the whole front, that is, from a point taken 1 third on the curtain, counting from the demi-gorge to the angle of the adjoining half baſtion.

Plate V. Fig. 3. I ſhall not produce a multiplicity of examples, nor extend to irregular figures, much leſs to thoſe fortified with whole baſtions; it is for the uſe of young engineers I write; for thoſe who have made this their principal ſtudy, I have, perhaps, ſaid too much.

V. Forts, open at the gorge, ſerving generally to cover the heads of bridges, are ſeldom left to their own defence.

For which reaſon, when the bridge is not made, they are commonly conſtructed at the middle of an elbow, which forming a kind of arch, have a better defence than a right line.

If the river is narrow, and the oppoſite ſide as high, or higher than that on which the work is, detached flanks are raiſed, whoſe effect is more certain, becauſe the ſoldier is leſs afraid of being attacked there.

If the river is 40 or 50 fathoms wide, or the ſides being low, oblige us to retire to ſuch a diſtance, as the

ſmall

ſmall arms can do no great execution before the ſaliant angles, the faces muſt be ſupported by flanks, which are raiſed on the ſhoulders of the work, or flung up at the inſtant of the attac, that is, when the enemy is near the ditch. We cannot ſometimes uſe this reſource.

The *Rhine* below *Straſbourg*, the *Danube* below *Ingolſtat*, and many other rivers, are above 100 fathoms broad, in which caſe, we muſt not expect any protection from ſmall arms, from one ſide of the river to the other, but the flanks before mentioned will always be uſeful, if ſome pieces of cannon are placed in them.

Artillery being abſolutely neceſſary in this caſe, and certainly the moſt proper arms to defend the acceſs to a work at a diſtance, we ſhall not find them leſs neceſſary in the others. An engineer ſhould then demand them.

VI. The ſize of theſe pieces is not determined by the number of men deſtined for their ordinary guard, but rather, by that of the troops that are, or may be advanced; becauſe they muſt be ſo conſtructed, that they may file off without confuſion, and muſt alſo favour their retreat.

The principal circumſtances, which can determine their figure, are reduced to 3 different caſes.

1ſt, When theſe pieces are near enough to be flanked from the oppoſite ſhore, a ſimple redan may be ſufficient: the inclination of the faces is regulated by the nature of the ground, and the parts to be commanded. Nothing more to be obſerved, but in proportion as the angle differs from 90 degrees, the capacity of the work diminiſhes, the more it is acute, the more direct and nearer its faces are protected. Plate VI.

When the defence is from ſmall arms, at a great diſtance, flanks muſt be added to the work, obſerving to ſcour the faces of theſe redans, from the other ſide of the river. Plate VII.

Theſe faces will not be too long, when the gorge is no wider than neceſſary for an eaſy communication, the

angle of the flank with the branches about 110 degrees. I executed this at *Donaſtauf*, near *Ratisbon*, in 1742, but had not time to make the intrenchment in the iſland, which is very low; I ſuppoſe it here on a level with the country.

When we have no other defence than cannon, all parts of the work, except thoſe next the river, being equally expoſed, they muſt be as equally flanked as poſſible.

Plate VIII. Fig. 1. Here are 2 works which may ſerve on ſuch occaſions. Form a ſquare; divide each ſide into 4 parts; take internally 1 of theſe parts for the capital; trace the curtain: take one of theſe parts for the gorge, draw the flank perpendicular to the line of defence.

For the branch, give to the capital and the gorge, 1 4th of the ſide, as in the front, except that the capital be carried externally: draw the line of defence from its extremity to the middle of the whole front; raiſe a perpendicular from the point of the gorge; prolong it internally half of its length, and from the point of prolongation draw the branch and flank, making an angle of 105 degrees.

This figure differing in many things, from what has either been executed or publiſhed, I will add ſome reflections.

The flanks are very large, but the *Terreplein* being of a ſufficient extent, and the flanked angle open enough, I ſee no diſadvantage in this: thoſe of the front being perpendicular to the line of defence, not diminiſhing the faces too much in themſelves, have a good defence, as producing a croſs fire. The others are more open, to give the fire at the extremity of the branch more play.

The inclination of the branches is yet more particular; 2 advantages reſult from it: 1ſt, ſuppoſing the courſe of the river in a right line, their fire falls before

1 part

1 part of the demi-baſtion of the gorge; the 2d, that the defence of the 2d flank, which ſhould graze the faces, is leſs oblique.

The 2d flank by this is ſhortened, but if we advert to the manner of eſtimating its fire, we ſhall find, that in regard to the grazing line, its effect is always the ſame.

The 2d figure has its front traced as the preceding; cut off 1 6th of the opening of the gorge; carry 2 of theſe 6ths on the branch; and from that point forming an angle of 120 degrees, draw the face of the demi-redan. Plate VIII. Fig. 2.

This method appears preferable to the firſt, if we are not to be protected from the other ſide of the river, as the branches are better defended: beſides, the flanked angles of the demi-baſtions are 62 degrees 6 minutes, which is ſufficient.

Theſe different heads of bridges, are to be eſteemed as good works againſt a ſudden onſet only, and their uſe almoſt momentary, as they ſometimes ſerve but a few days, and at moſt during a campaign.

VII. There are ſome more durable, ſuch as are commonly conſtructed before *Hunningen* and *Fort Louis*, and the enemy before *Philipſbourg*, at the beginning of a war againſt the emperor, or ſome other power of the empire.

The only 1 I was ever employed in, was raiſed in 1733, after the taking of *Fort Keel*, in the iſland of *Selingen*. I was, as chief of the brigade, charged with its conſtruction, but did not trace it; it was a horn-work, I do not remember its proportions, or how the branches were defended, to give it here as an example.

In general, theſe little fortreſſes are deſigned to ſubſiſt till a peace, and ſeldom can expect any aſſiſtance but from ſome neighbouring garriſon, they muſt be not only conſtructed with ſolidity, but fortified, ſo as to ſuſtain a regular attac, long enough to be ſuccoured from a conſiderable diſtance.

That which covered the bridge of *Philipſbourg*, in 1734, was a horn-work, of 45 fathoms in front, with a ravelin, and its branches, which opened and ſpread from the ſaliant angles, were flanked by demi-baſtions; we frequently find figures of this kind on the *Rhine:* if either of the conſtructions I have given ſhould be uſed in the like caſe, the front muſt either be more than 60 fathoms, or the faces longer, without which the ravelin will not be ſufficiently defended.

Theſe works being generally planned and executed more at leiſure than the others, the whole art of fortifying places may be here practiſed; in 1742, I projected the half of a ſquare for the bridge of *Deckendorf*, the *Danube* forming the diagonal; an epidemic diſorder raging at that time amongſt the ſoldiers, there were left ſcarcely ſufficient for more indiſpenſible ſervice. This figure is of great extent, and encloſes little ground; circumſtances, which added to others, determined me to prefer one to it, which I ſhall mention hereafter.

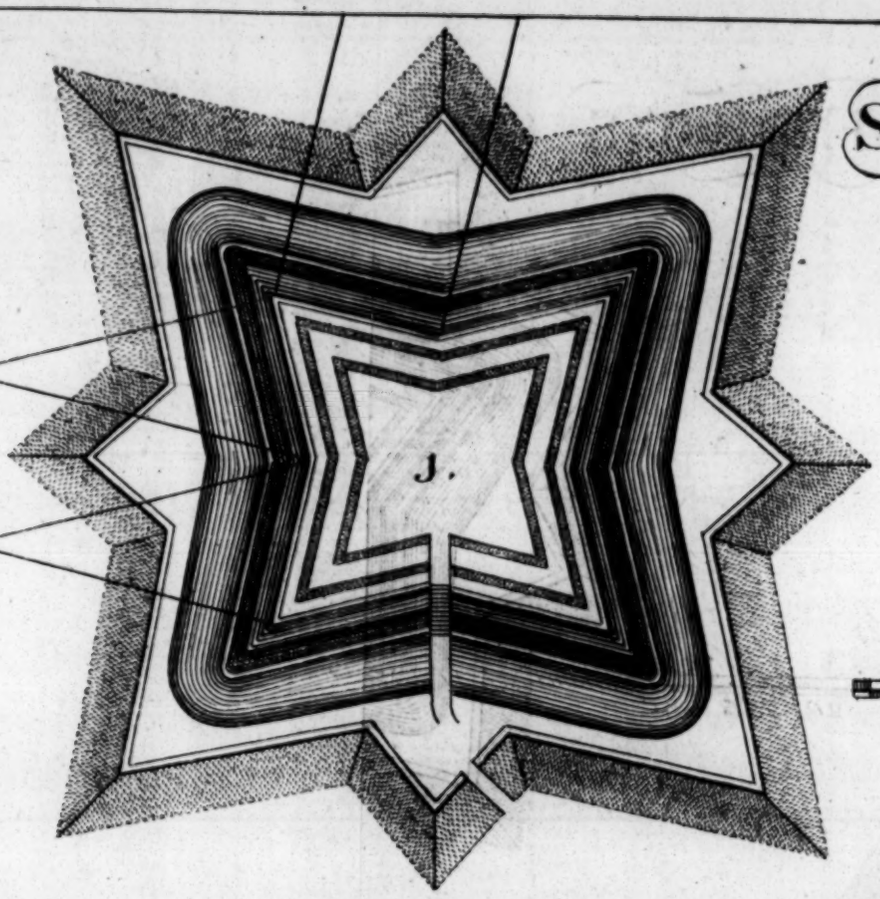
This half ſquare was conſtructed according to M. *de Vauban*'s method, except that having no reaſon to fear the line of defence would be too long, I ſhortened the faces, to lengthen the flanks, which I made, for the reaſons already mentioned, perpendicular to that line.

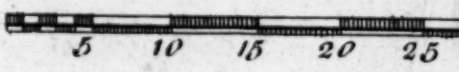
The front of the polygon was 60 fathoms, which is the leaſt this figure can have, even for a field fortification. They will be deemed right, if we reflect on the ſmallneſs of the flanks and *Terreplein*.

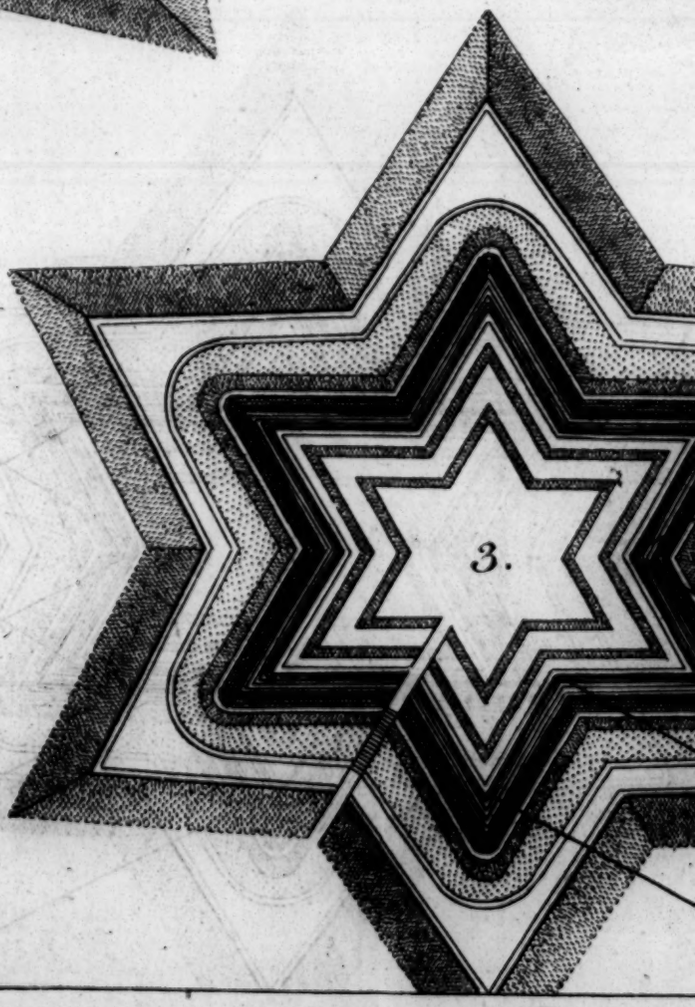
The work which covered the head of the bridge at *Philipſbourg*, after taking that place, made by the *Dauphin* in 1688, was larger, but ſimilar to this.

VIII. Every work is only fortified, in proportion as it has flanks, and in the different caſes mentioned, we may not always be able to give them as much extent as neceſſary, without too much diminiſhing the figure: the proximity of a moraſs, a rivulet, a low ground, the neceſſity of occupying eminences, eſpecially for the ſaliant

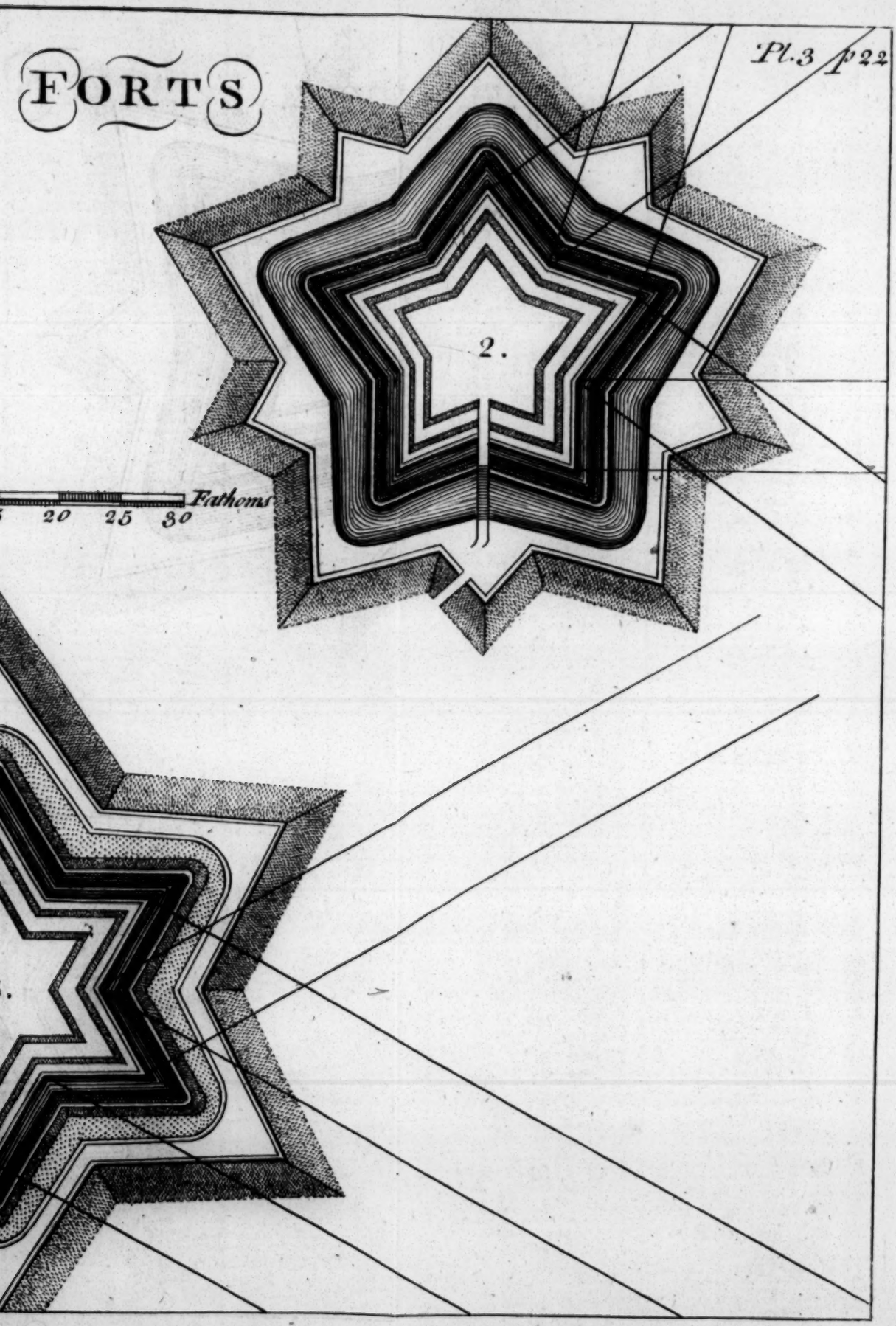
STAR FOR







FORTS



liant angles, without which, the branches, and perhaps even the *Terreplein*, are expoſed, are difficult obſtacles to ſurmount.

This reflection gave riſe to an expedient, which I had formerly propoſed to the court for a different uſe; which is, to equip 2 boats, with 2 pieces of cannon in each, and as many ſmall arms as ſhall be judged neceſſary; when boats cannot be found large enough, many may be faſtened together to form pontoons.

The movement of this machine is the ſame as our common ferry-boat, that is, by making a cable paſs on 2 turning cylinders, or rings faſtened to its ſide, 1 end of which is faſtened to the bridge, and the other to an anchor, caſt at ſome diſtance in the river.

If the current is not very ſtrong, the cylinders, or rings, are faſtened 1 on each ſide, ſo as to give the ſide of the boat its proper direction; if it be ever ſo little rapid, the boat muſt have its head to the current, or it will be in danger of being drove on ſhore. A parapet of madriers, or double planks, may be made, if neceſſary.

If the attac is made with cannon, theſe moveable flanks are brought behind the gorge of the work, and do not appear till the enemy ſhall be near enough, that they may have their full effect. The ſurprize, which the unexpected ſight of thoſe floating batteries, will produce in the aſſailants, is another advantage, and if they do not put them into diſorder, they will probably ſlacken their ardor.

I ſuppoſe here the river not ſo buried in its banks, but that we can command the country from the platform of the boats. This ſcheme ſtruck me at *Deckendorf*; it is practicable on the *Danube*, in almoſt every part I have ſeen; the following year arriving at *Wormes*, I found it done on the *Rhine*, but in a leſs perfect manner, for the boats were fixed.

The great defence, and above all the ſurprize, were the only objects I propoſed at *Deckendorf*, where, by

the uniformity of the ground, I could have given what figure I pleaſed to the work: but this expedient is not confined to circumſtances.

IX. We frequently employ theſe veſſels in places for other uſes; they may alſo be of ſervice in the field, as this concerns the engineer only, as he may be obliged to defend himſelf againſt them, I ſhall inſert ſome examples to ſupport what I have advanced.

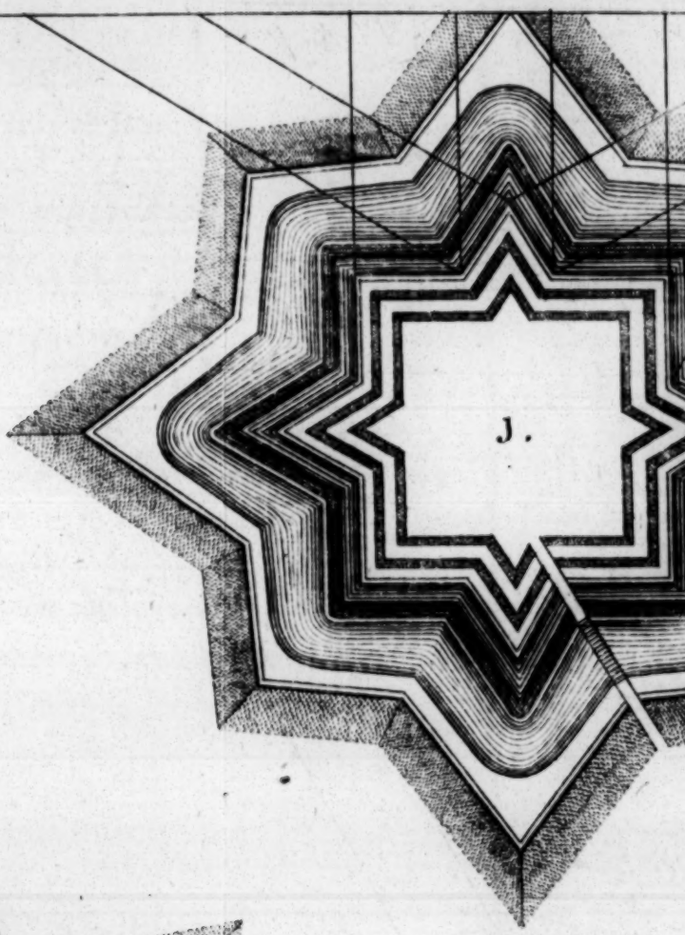
I ſaw at St. *Omers*, in 1710, or 1711, boats armed with one cannon, whoſe carriage turned on a pivot, as occaſion required; they had at the ſame time gailiots on the inundation of *Conde*, and ſome were built in 1735 at *Straſbourg*. It is known, that when the *Imperialiſts* were at war with the *Turks*, they had whole fleets of * *Saiques* towards *Belgrade*.

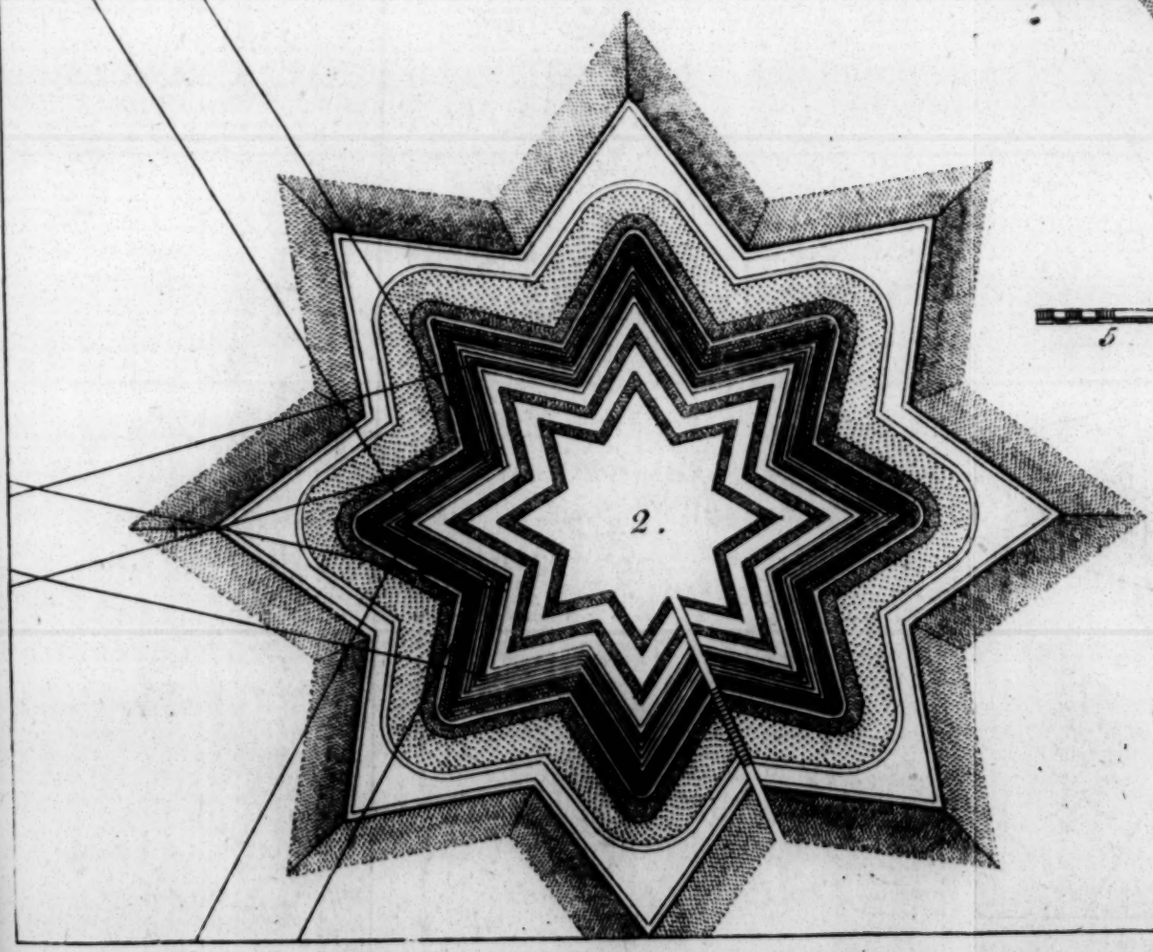
The *Auſtrians* had them in *Bavaria*; and as the rout from *Nieder-Altach* to *Deckendorf* is croſs an even and open plain, ſtraitened in ſome places by the *Danube*, and mountains, our army would probably have been diſturbed in their march of the 18th of *Auguſt* 1742, if count *Thoring*, who in concert with count *Saxe*, ſuddenly paſſed the *Iſer* at *Pladling*, had not by that bold ſtep obliged M. *Khevenhuller*, to turn all his attention and forces that way. The *Saiques* did not appear till 2 days after; they concealed themſelves to the number of 10 or 12, under cover of an iſland, at the mouth of that river, from whence they cannonaded our guards of cavalry, and annoyed our bridge; the huſſars and pandours over-run the plain: I had propoſed on the 30th of the preceding month, to raiſe a battery on that iſland: it was at length done, and we ſaw nothing after, either on the plain or the *Danube*, to the night between the 5th and 6th of *September*, when we decamped to

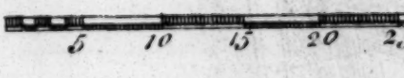
* *Saick* or *Saique* a *Turkiſh* veſſel, with a bowſprit, ſmall mizen, and main-maſt, which, with its maintop-maſt, is ſupported at an extraordinary heighth, by ſtays from the top-maſt, to the bowſprit and ſides.

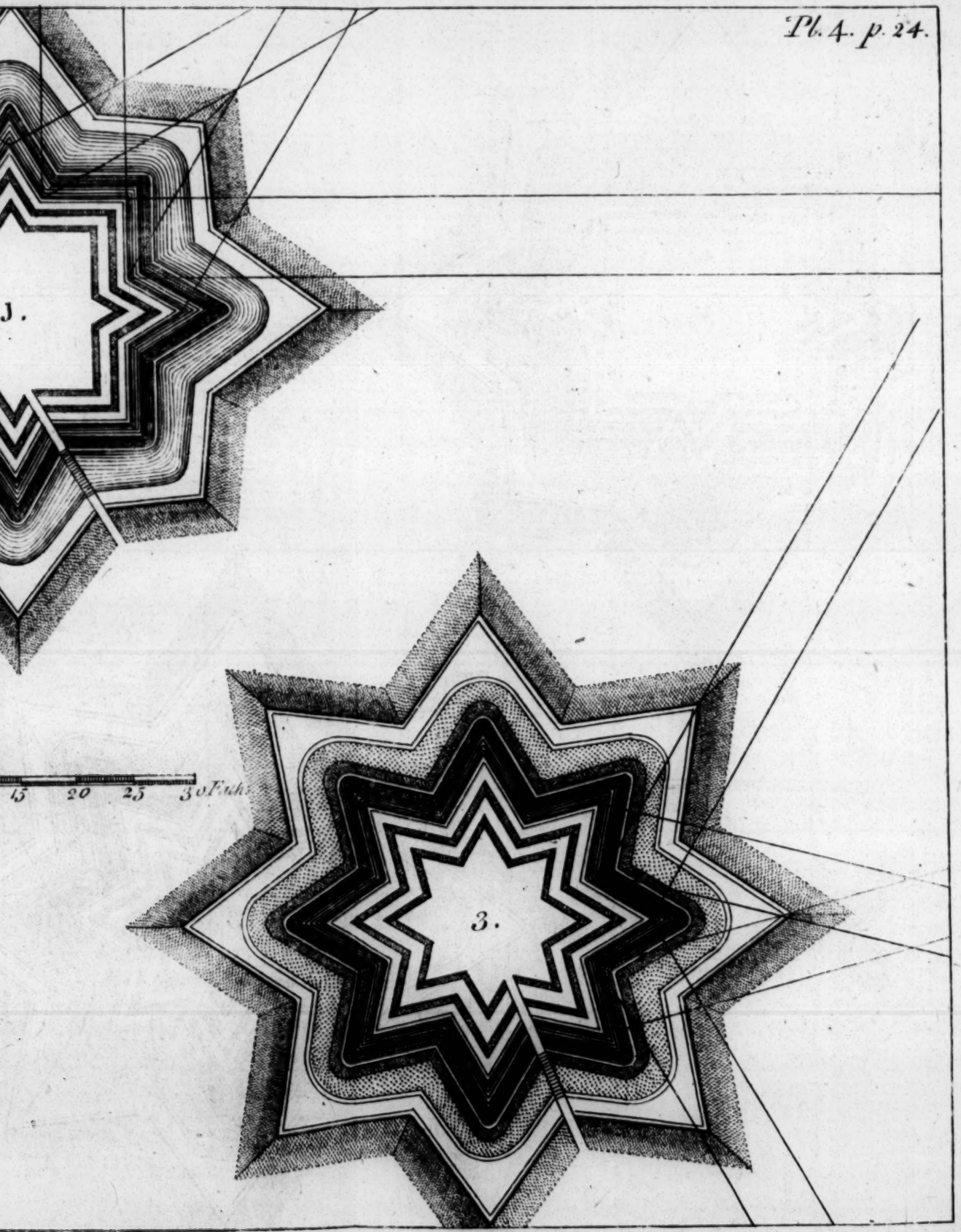
join

STAR FORTS








J.
3.
15
20
25
30 Fuh

join the army of M. *de Maillebois*, by the rout of *Bohemia*.

OBSERVATIONS on the ſecond Chapter.

The conſtructions of forts and bridge-heads, having been little taken notice of by writers, our author, judging them abſolutely neceſſary, treats of them here: and as his method is ſomething particular, and ſuppoſes the reader to be acquainted with the common practice, which not being always the caſe, we thought an explanation would be uſeful to beginners.

After the redouts, the forts with points or ſaliant angles, commonly called *ſtar forts*, are the moſt ſimple, that have ſome defence, though very oblique; they are made from 4 to 8 points: the ſquare conſtructed, by making the perpendicular FE to the middle of the ſide AD, equal to 1 8th part of that ſide; but in the pentagon this perpendicular is 1 6th part of the ſide. In the exagon, an equilateral triangle is made upon each of the ſides. Plate A. Fig. 2.

The octagon may be traced in the ſame manner as the exagon; that is, by making an equilateral triangle upon each ſide: but as this conſtruction is difficult in the practice, the author gives the following: find the ſquare one ABCD as before; divide each of the ſides AE, DE, into 3 = parts, and make upon the diſtance between the points of diviſion G, H, next to the point E, an equilateral triangle, which forms the angle GLH. As to the *ſtar fort* of 7 points, it is never uſed, being difficult to trace on the ground. Fig. 2.

The defence of theſe forts being ſo very oblique, eſpecially in a ſquare, and the conſtructions of the others requiring too much time and workmanſhip; they are ſcarce worth making, except on ſome very particular occaſions. The forts next in rank are thoſe with half baſtions; which are not much better, as having their faces very little defended; the conſtruction of the triangular is; take the part AD of an equilateral Plate A. Fig. 3.

equilateral triangle ABC, = to 1 4th of the ſide AC, draw BD, in which take DE equal to DA, and draw the flank EF at right angles to BD; then AF will be the face of the half baſtion, and EB the curtain.

Inſtead of half baſtions, I would make whole, placed in the middle of the ſide, as in this figure; where the gorge DC and the capital EF are each 1 5th part of the ſide AB; the flanks are perpendicular to AB, and equal to 1 10th part of the ſide, or half the gorge. By this conſtruction, the ſaliant angle F is right, which is preferable to any other; and there is no part but what is ſeen and defended by ſome other; the 2d flank which defends the face is 4 5ths of half the ſide BE; and therefore the direct flank BL is about 2 5ths of BE nearly. As this figure is more regular than the former, it will contain a greater ſpace within the ſame incloſure.

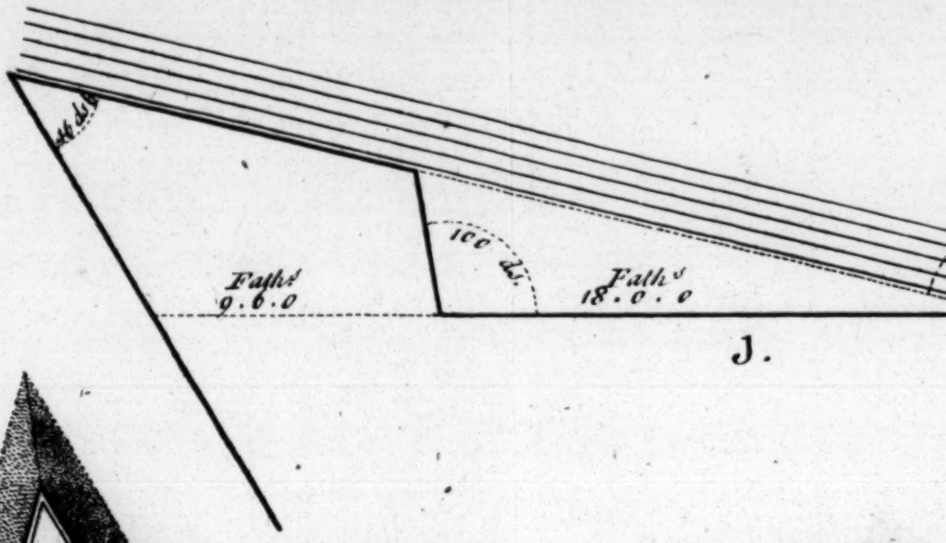
Fig. 4.

The conſtruction of the ſquare fort is; produce the ſide DC to E, ſo as CE be equal to 1 3d of DC; divide the ſide BC into 3 equal parts in G, H, draw the line of defence EH and the flank GF perpendicular to the ſide BC. Though the faces of this fort are defended by a 2d flank equal to half the ſide of the ſquare, yet by the great difficulty of firing ſo obliquely over a parapet of 8 or 10 feet thick; the following fort with whole baſtions is preferable, and more practiſed. Make the perpendicular CD to the middle of AB, equal to 1 10th of the exterior ſide, and the faces AF, BG equal to 1 4th of that ſide: the flanks are drawn at right angles to the lines of defence.

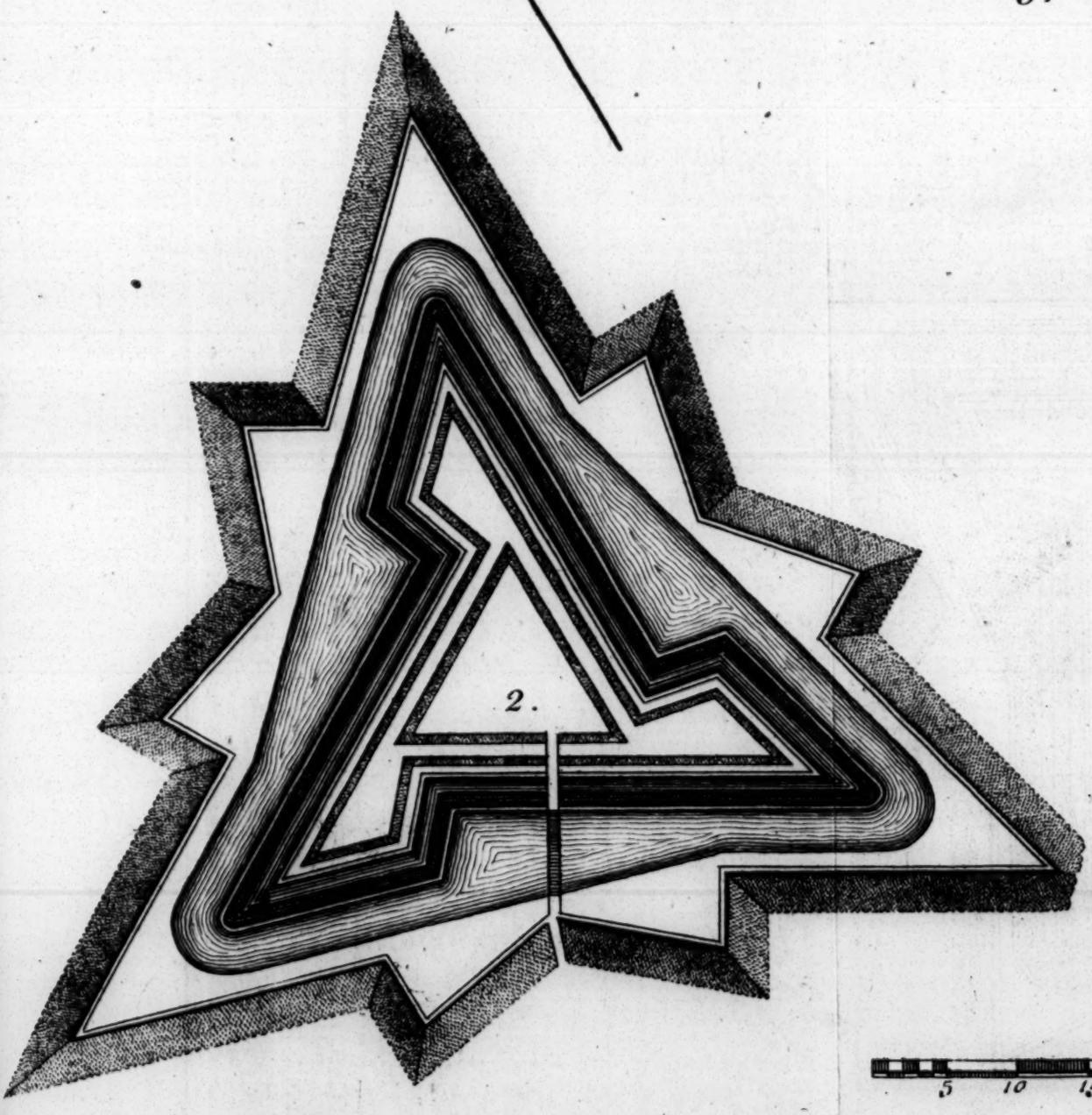
Fig. 5.

Fig. 6.

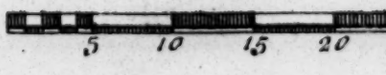
The bridge-heads are made of various figures and ſizes, ſometimes like a redan or ravelin, with or without flanks, ſometimes like a horn or crown-work, according to the ſituation of the ground, or importance of its defence. Their conſtruction depends on various conſiderations; when the river is ſo narrow, that the work may be flanked from the other ſide, a ſingle redan

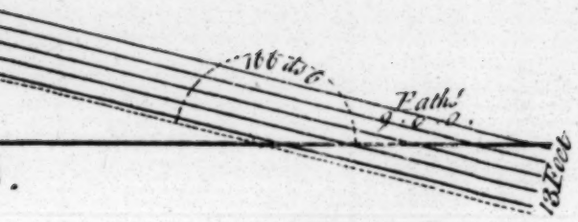


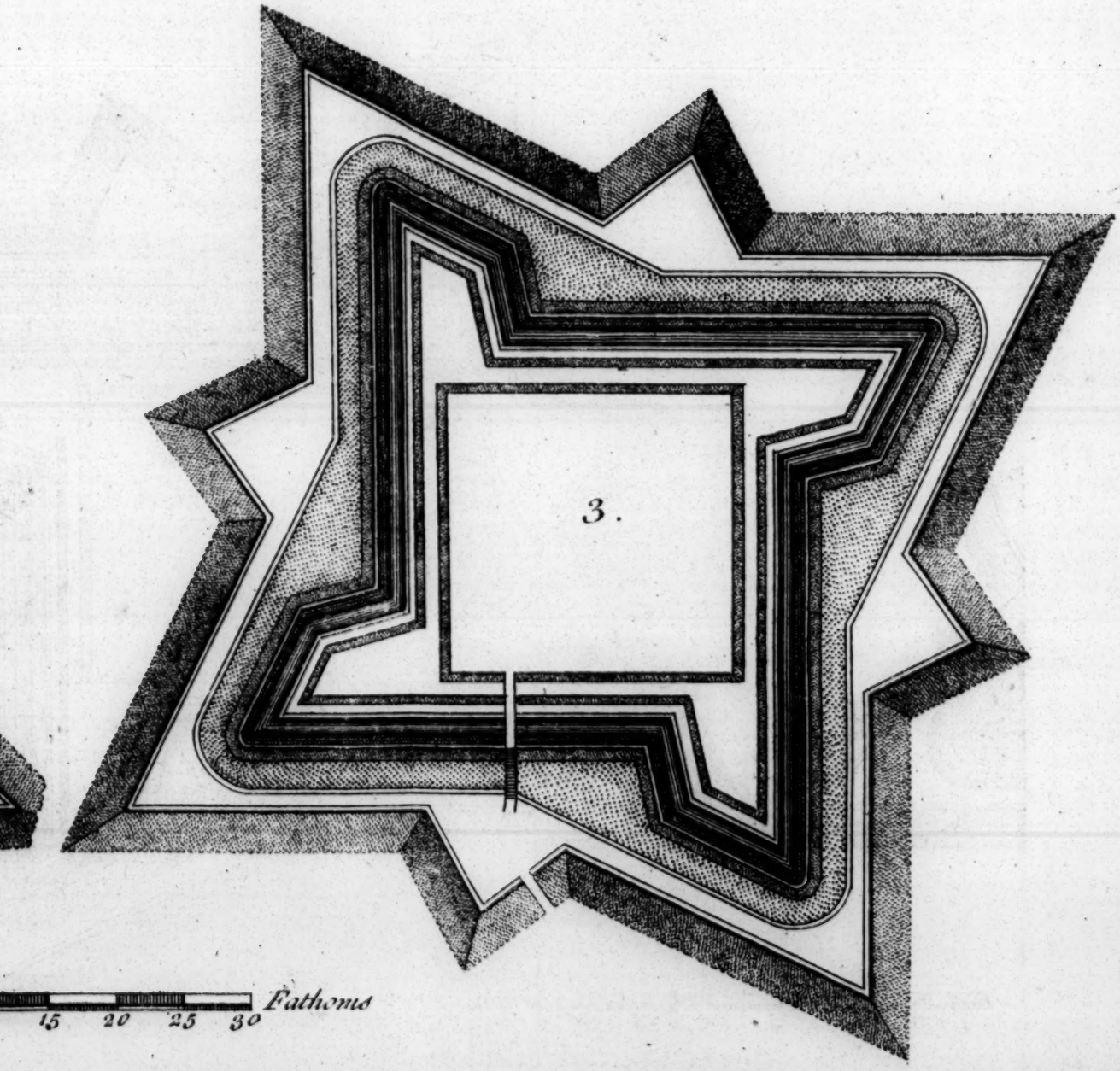
J.



2.




Paths
18 Feet


3.

15 20 25 30 Fathoms

dan is ſufficient, but when the river is ſo broad, as that the ſaliant angle cannot be well defended croſs the river, flanks are made to the redan: if the river is 100 fathoms or more a-croſs; half a ſquare is made, whoſe diagonal is the river ſide: but when it is from 3 to 500 fathoms broad, a horn or crown-work ſhould then be made.

A river may be ſtrait or crooked; if it be ſtrait, the bridge is made before the middle of the front of the army; and ſometimes 2 at equal diſtances from the center and wings; ſuppoſing the ground to be equally favourable, otherwiſe they are placed where moſt convenient.

If the river be crooked, the inward bend is to be choſen; for ſuppoſe a, b, c, to be its courſe, if the bridge is made at b; the enemy cannot ſee, or flank it from any part on the other ſide; the batteries placed at K and L flank and defend not only the faces of the head P, but likewiſe all the part D, E, about it; by which the troops may march out, and draw up in order of battle, without the enemy having it in his power to diſturb them, but at a great diſtance. On the other hand, if the bridge was made at the outward bend as at a or c, it would be enfiladed from both ſides, the head could not be defended but from a great diſtance, and very obliquely; and the troops could not form before the work, without danger of being charged immediately by the enemy. Therefore ſuch a ſituation ſhould be avoided if poſſible. Fig. 7.

When the river is narrow, a triangle ABC is made upon the bank AC of the river, ſo as the ſaliant angle B, may not exceed a right angle, nor be leſs than 60 degrees; which may be done at ſight, without the help of an inſtrument: as to the length of the ſides AB, BC, it depends on the number of men to defend it. For inſtance, ſuppoſing 3 rows at 3 feet diſtance, then 6 times the length of one face expreſſed in yards, will be the length required. If therefore each face Fig. 8.

face is 50 or a 100 yards; it would require 300 or 600 men to defend it: beſides a body to ſupport them, and to ſupply the places of the killed and wounded.

If ſuch a work requires flanks, take AE equal to 1 4th of AB, erect the flank EF perpendicular to AB, and equal to AE, draw the line of defence BF, which, when produced, determines the face FD.

When the river is ſo large, that no defence can be expected from the other ſide; conſtruct half a ſquare ABC, in the ſame manner as in the 6th figure, and ſo as the diagonal AC be the river ſide.

Fig. 9.

When the bridge is to remain during the courſe of a war, ſuch as that built at *Fort Louis* upon the *Rhine*, it requires a larger work than the preceding; for which reaſon, a kind of horn or crown-work is to be made, or ſuch as is repreſented in this figure, which is thus conſtructed. Let ABCD be a ſquare, take BE CF, each equal to a 4th part of the ſide, draw EF, in which take the parts EG, HF, each equal to 1 4th alſo, or to BE, and CF, draw the lines of defence BH, CG, and the flanks GL, HK, perpendicular to CG, BH the lines of defence.

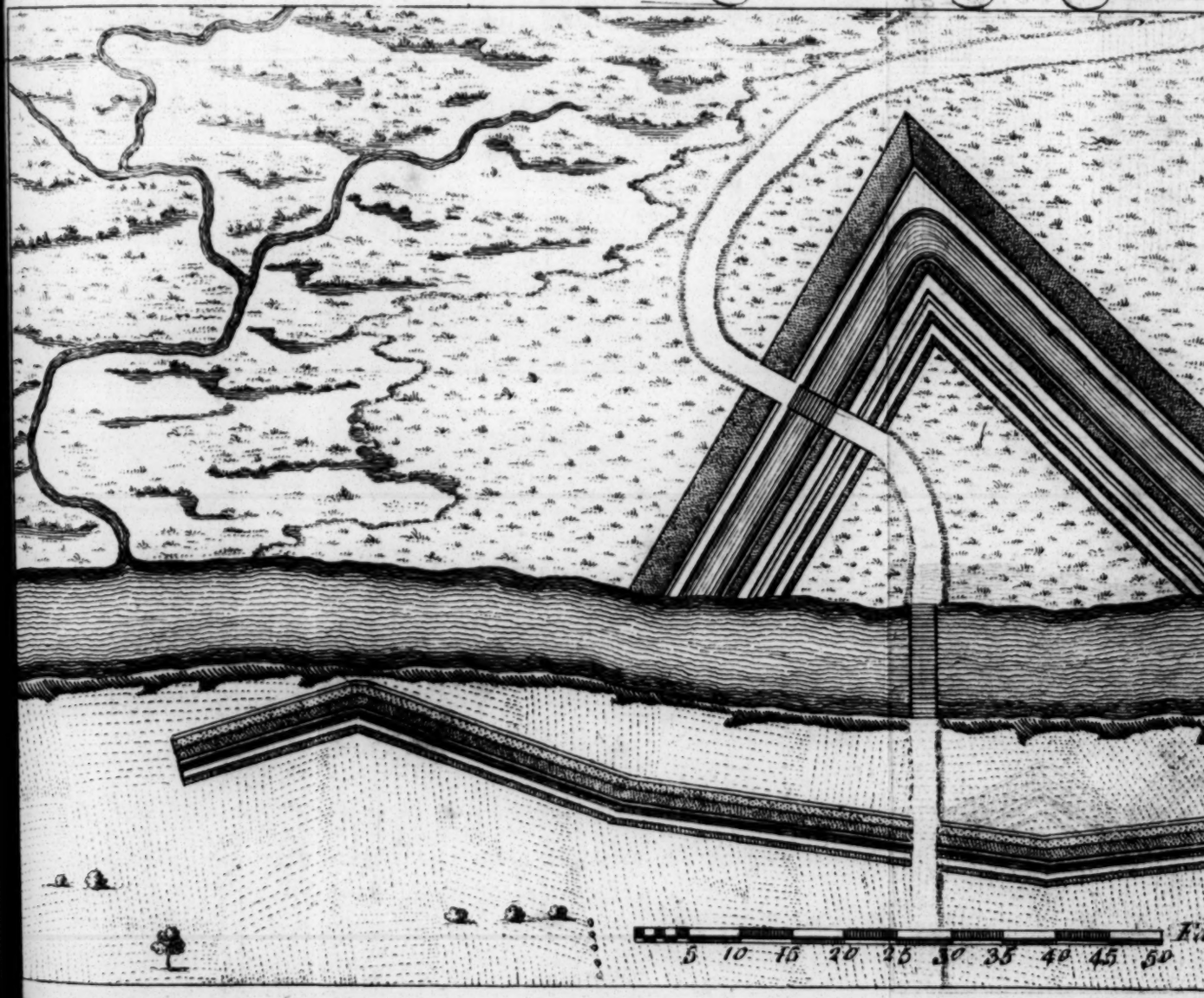
Fig. 10.

The branch PROC is conſtructed, by ſetting off from the point D, the part Da upon DC, and DP upon AD produced, each equal to 1 4th part of the ſide AD; take aQ equal to Da, and draw the line of defence PQ: then if through the point a, the line bO be drawn at right angles to DC, and aO be taken equal to half of ab, the curtain CO is drawn to that point, and the flank OR at right angles to it, or ſo as to make an angle of 105 degrees. The 2d manner of conſtructing the branches is, to take AS on AD, equal to 1 6th part of the ſide, and in BS, the part ST equal to twice AS; from the point T, the flank TV is drawn ſo as to make the angle BTV equal to 120 degrees.

This 2d method is eſteemed by the author preferable to the firſt, but in my opinion ſpreads its fire too much: the firſt conſtruction is more troubleſome than the ſub-

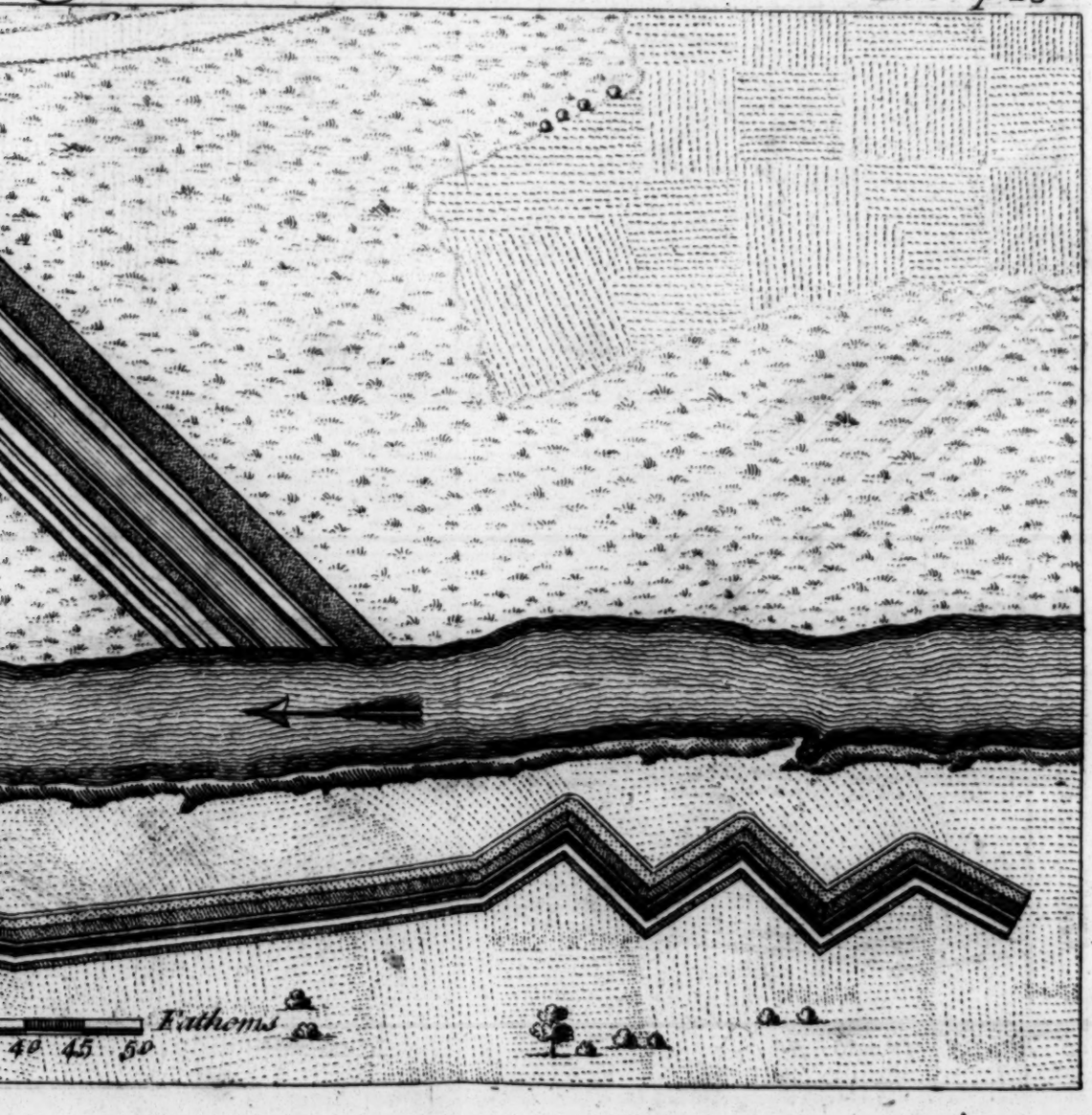
ject

BRIDGE HEA



HEADS

Pl. 6. p 28.



ject requires, and does not agree with the author's profeſſed ſimplicity: it may be done thus; take DN on AD equal to 1 6th of that ſide, as has been done on the other ſide, draw CN, in which take NO equal to 1 4th; then the flank OR is drawn either at right angles to CO, or ſo as to make an angle of 100 degrees; and equal to NO.

This front muſt be covered by a ravelin, ditch and covert-way, as well as all works of this kind that are to remain for ſome time. When an iſland is to be found in a large river, the bridge is to be made there; becauſe it ſhortens it, and an intrenchment may be raiſed, either to defend the head, or to cover a retreat; ſuch ſituations are frequently found on the *Rhine* and *Danube*, and never neglected by the *Germans* or *French* when they croſs theſe rivers.

CHAPTER THE THIRD.

I. *Examples of the method of fortifying a church-yard.* II. *A church.* III. *An old caſtle.* IV. *A country-houſe.* V. *Attack of a country-houſe.* VI. *Inſtructions on the different ſubjects of this Chapter.*

I. BEſides poſts, which require the works we have treated of in the preceding chapters, there are others which demand our attention. They are fortified according to the time, numbers, and means we are maſters of, and the uſe we would make of them: I ſhall explain myſelf bettter by examples.

The firſt of *October* 1742, having ſet out with 21 engineers, from the camp of *Bramerhof*, to go to *Amberg* the next day, 3 leagues below *Tirſchenreit*, we found a conſiderable body of Huſſars, waiting for us at the end of a wood, who at firſt kept at a diſtance, the better to reconnoitre us.

Our

Our eſcort conſiſted of 33 men of the independent company of *Limont*, in general badly provided with piſtols, and our baggage liable to put us into confuſion, yet determined to go forward, we paſſed thro' the village of *Pſaffernreit* without ſtopping.

Scarcely were we got out, when the huſſars, who had taken a tour round it, briſkly attacked us with piſtol and carabine; this did not prevent us continuing our journey with a ſlow pace, and in good order, till we were oppoſite to *Miteldorf*.

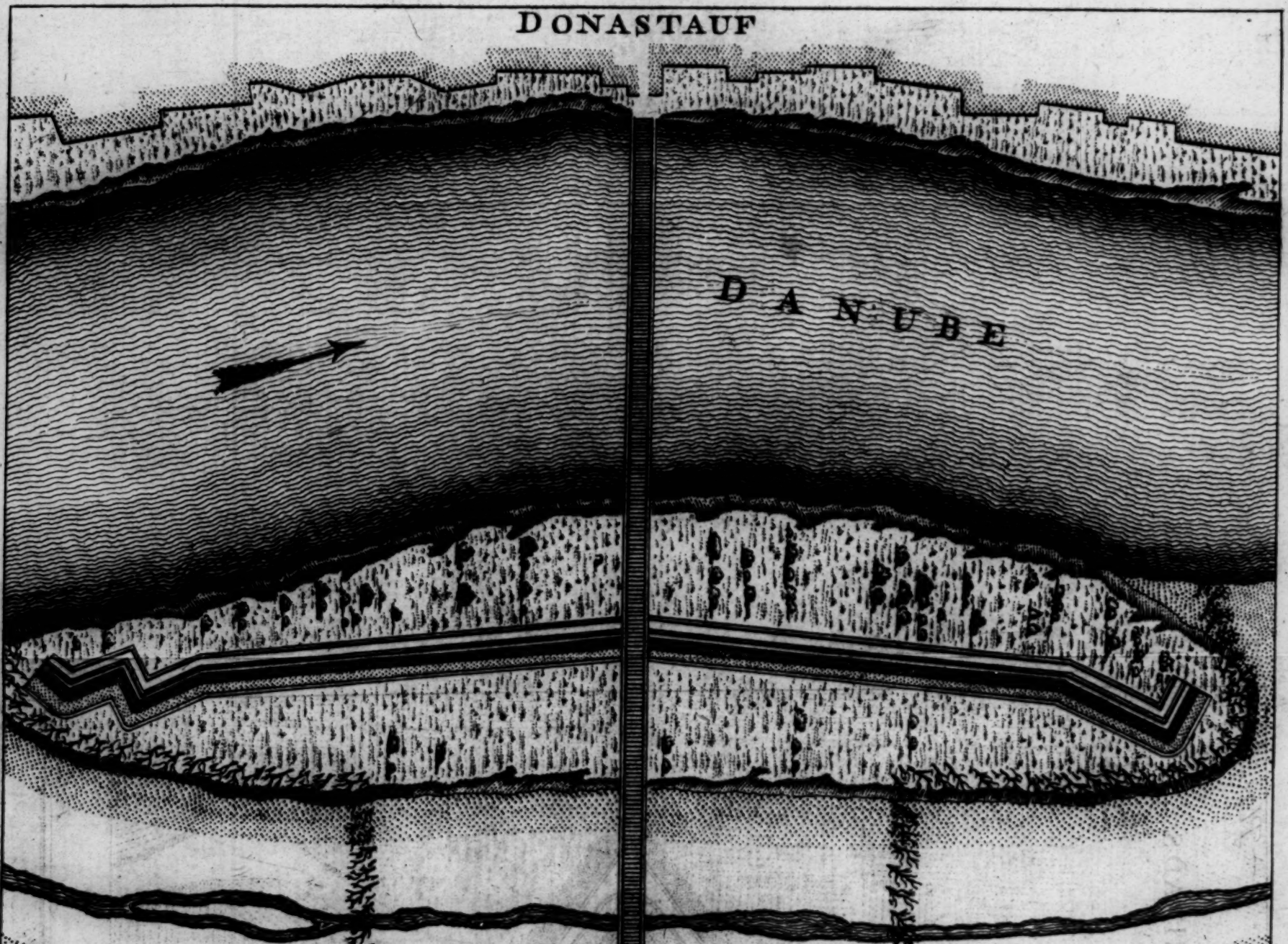
This ſkirmiſh laſted above an hour; 2 engineers were taken, 1 of whom was wounded, another was alſo wounded, with 4 domeſtics. The enemy did not ſuffer leſs, but they were not diſcouraged, their number encreaſing every moment; the more we advanced, the leſs hopes we had of aſſiſtance: theſe circumſtances determined us to throw ourſelves into the village.

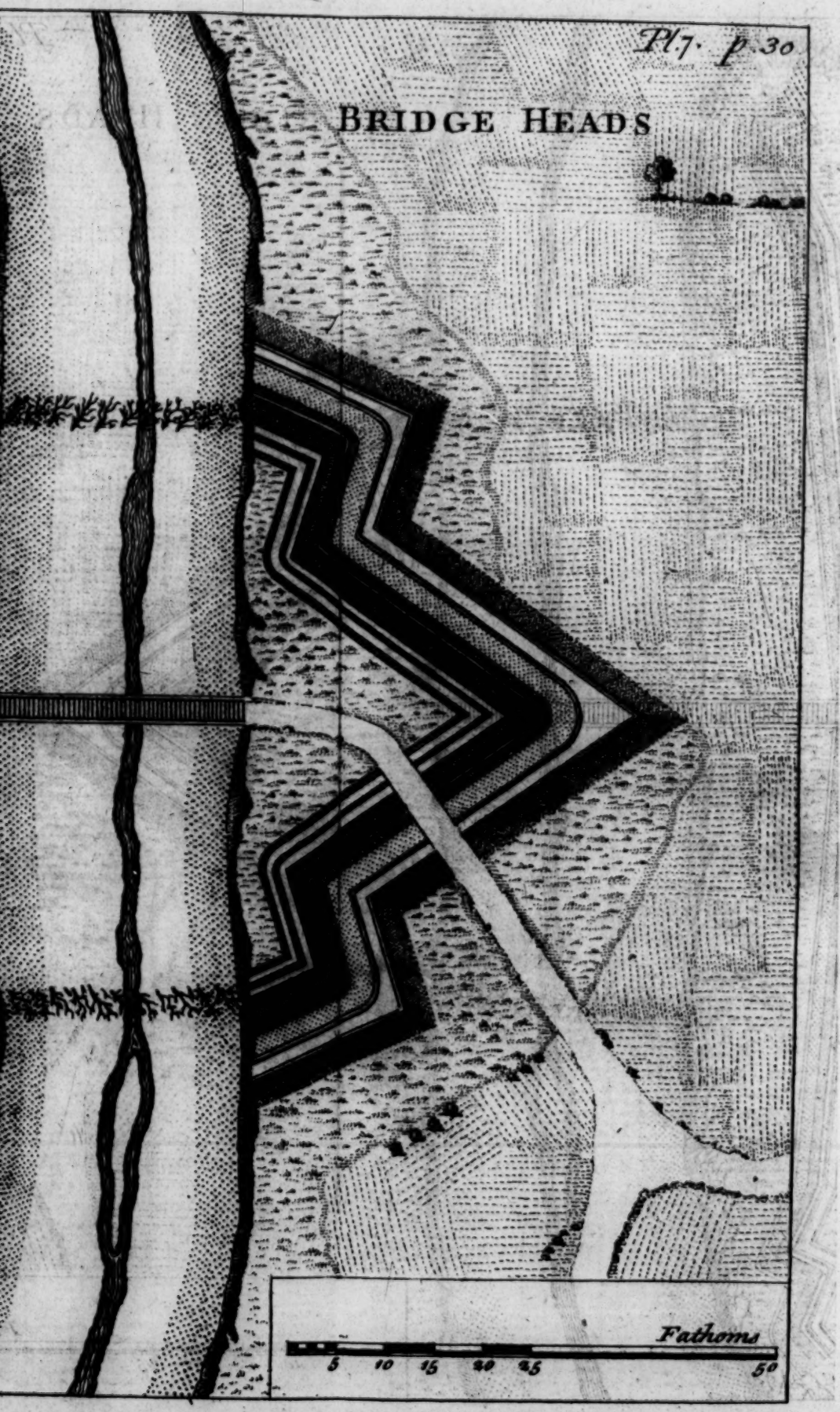
We ſoon ſaw that this was no aſylum, we found neither church nor walls to encloſe us; this place conſiſts of 12 houſes of wood, or deal planks laid on one another, and pinned at the corners, according to the cuſtom of that country. We had all the dreadful effects of fire to fear, a kind of attack very inhuman, yet cuſtomary with thoſe we had to deal with, and who were encouraged by a conſiderable ſum, which they found on one of the priſoners; this made us certain, that if they quitted us, it was only to return in a little time with a greater body.

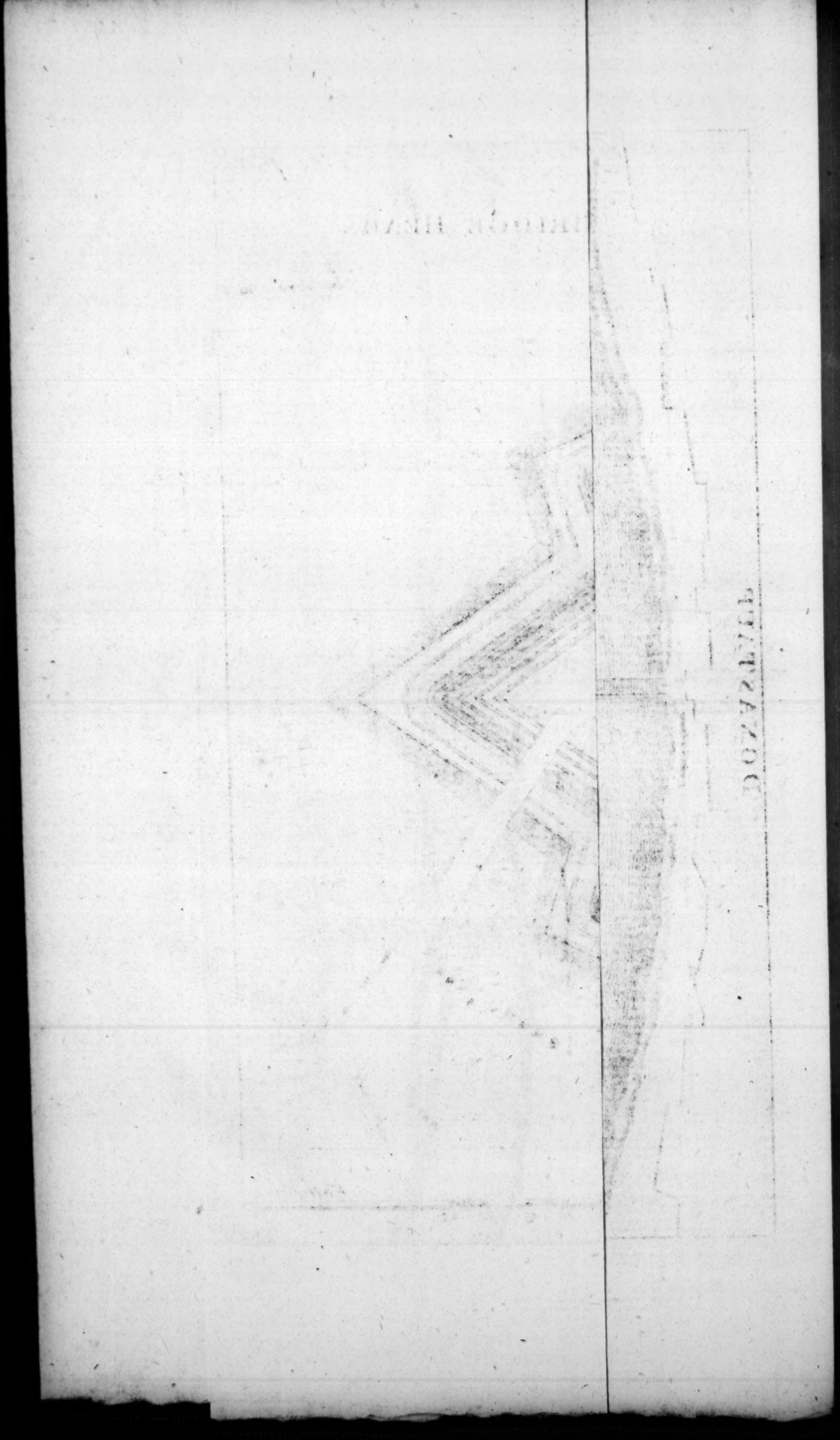
In this dilemma, we reconnoitred and reached *Vurz*, a village, in which we perceived a ſteeple, about the 8th part of a league on our right.

Having carefully examined the avenues, and barricaded them with trees, baggage waggons, carts, &c. from each of which we took a wheel or 2: we raiſed a banquet along the wall of the church-yard, where we fixed with our baggage; making uſe of the church, in the door of which we had cut loop-holes, as a citadel, and the ſteeple as a redout, which muſt be our laſt ſhift.

Two


DONASTAUF
DANUBE


Pl.7. p 30
BRIDGE HEADS
Fathoms
5 10 15 20 25 50



Two ſtone houſes almoſt touched our bounds, but being built on very low ground, the height of their walls did not exceed that which ſerved us as a parapet. We would not open theſe walls, and yet we muſt have a communication with thoſe houſes; the poſſeſſing them was abſolutely neceſſary, as well to avoid being overlooked, as to give us ſome flanks. We therefore judged it beſt to conſtruct our communication in form of a bridge, from the top of the intrenchment into the roof, and having barricaded the doors and windows in the lower floor, we here fixed ſome guards.

The recital of what we did upon this occaſion, may ſerve as an example how to act upon a ſimilar one: tho' our precautions were prudent, they happened to be uſeleſs; the huſſars, being tired of waiting for us on the road, went off to return the next day in a greater body; in the interim, after we wrote every where for ſuccour, and could get no more than 50 men of the ſame company, who had orders to go no farther; we retired, and got to *Tirſchenreit*, before they returned.

II. The church of *Vurz* was certainly a more ſecure poſt than the church yard; but as we would not abandon our horſes, nor put them into the church, this retreat required works which we had neither time nor means to execute.

When a church is to be defended, the doors muſt be covered with breaſt-works, of thick palliſades, joined or lined with planks: the loop-holes muſt be 6 feet high at leaſt, that the enemy may not reap any advantage by them: the earth of a little ditch which ſurrounds it, ſerves to form the banquet.

The doors and walls muſt alſo have loop-holes, or, if the walls be too thick, make them in the windows; this ſuppoſes a ſcaffolding, which ſhould run round the whole building, to facilitate a communication from one part to another.

If the church be in form of a croſs without, it in part flanks itſelf; if not, the veſtry at leaſt flanks one of

of the long ſides, and the breaſt-work ſhould be ſo diſpoſed, as to produce the ſame effect on the other.

There remains then only the rear of the choir, abſolutely defenceleſs, this is remedied by piercing a 2d row of loop-holes, low enough to diſcover the adjacent parts before it; or elſe project from the windows and the roof (and as high as poſſible for fear of fire) ſome little *Machicouliſes* of wood.

If the ſteeple affords not the ſame advantage as the veſtry, it may ſerve at leaſt to ſee what paſſes at a diſtance, and as a redout to capitulate in, in caſe ſuccours do not timely arrive. The church of *Berg*, a village in the neighbourhood of *Lauterbourg*, was intrenched thus during part of the war, terminated by the treaty of *Radſtat*.

III. Caſtles, and large well-built country-houſes, are preferable to churches, as greater advantages accrue from them.

I ſhall explain myſelf from occular demonſtration; this manner of inſtructing, I am ſenſible, flatters an author, but rouſes the reader's attention, who generally has more regard for the recital of facts, than ſimple precepts.

The firſt caſtle I had orders to reconnoitre was that of *Natterburg*, half a league from *Deckendorf*, on the *Danube*.

Plate IX. It was the ruin of a conſiderable fortreſs for a private man: it poſſeſſed the whole ſummit of a very ſteep hill, which was long and ſloping, and almoſt every where of an equal breadth: the buildings were in ruins, but the ſurrounding walls ſolid and well preſerved.

In the plan annexed, no flank can be ſeen in the ſurrounding wall, becauſe in my paſſage through I diſcovered none, perhaps, not being able to penetrate into ſome places encumbered and obſtructed by the falling of the floors and roofs; but the ſteepneſs of the hill on three ſides, and the other, that is, the extremity of the

Eſplanade

Eſplanade being of little extent, and furniſhed with a ditch, ſupplied this defect.

A very material circumſtance was, that the walls of the fore-court were about 15 feet high, and thoſe of the caſtle more than 30, and not made with loop-holes.

This little fortreſs, as may be ſeen, cannot be attacked but on the front of the *Eſplanade*, which the firſt builders had in view, at leaſt we may judge ſo, by the different walls, which muſt be broke thro', or got over, on that ſide, before it can be taken.

It will therefore be ſufficient, to erect 2 ſcaffolds, at the 2 angles of the rear of the caſtle, ſo high as to diſcover what paſſes over the ſurrounding wall, and ſo diſpoſed as to flank the 3 ſides, if neceſſary.

As to the principal walls of the front, *viz.* Thoſe of the caſtle, the *Fauſsbraye*, and the fore-court, muſt have banquets, platforms, and loop-holes, alſo holes made in the moſt convenient places, large enough to ſerve for embraſures for ſome ſmall pieces of cannon.

It is alſo neceſſary to repair the breaches in the wall of the *Eſplanade*, with dry ſtones, or cloſe them with palliſades, to palliſade the bottom of the ditch, to fraiſe the parapet of earth, and render the road impaſſable, when the enemy approaches, by felling trees, *&c.*

This poſt, thus repaired and provided with ſtores, with 3 or 400 men for a garriſon, would be able to ſuſtain a ſiege.

IV. The 1ſt of *Auguſt* 1742, I received orders to fortify the caſtle of *O*, a country-houſe, ſituated between *Deckendorf* and *Regen*, from which it is about a league diſtant.

My works were neither remarkable for their ſingularity or expence, they were indeed trifling, but the action which I ſhall mention, proves that theſe trifles were ſufficient, the detail may be uſeful to a young engineer, or one who has had little experience in this part of his duty.

This caſtle is built on the ſummit of an eminence; the acceſs to it impracticable on one ſide, and very difficult on 2 others: the plan annexed, which muſt be attended to in reading the ſequel, will explain the reſt.

My firſt attention was to maſk the doors with breaſt-works of firr-plank, planted one againſt the other, and elevated without from 8 to 10 feet, as I found it neceſſary to cover the adjacent heights, and made loop-holes at every 3 feet.

Theſe breaſt-works, whoſe ſides flanked where it was neceſſary, have a banquet, and that of the great gate, the only 1 not cloſed up, a barrier of planks with loop-holes.

The rear-court and the barn had no communication with their breaſt-work, but what were ſo low, as not to be diſcovered from without.

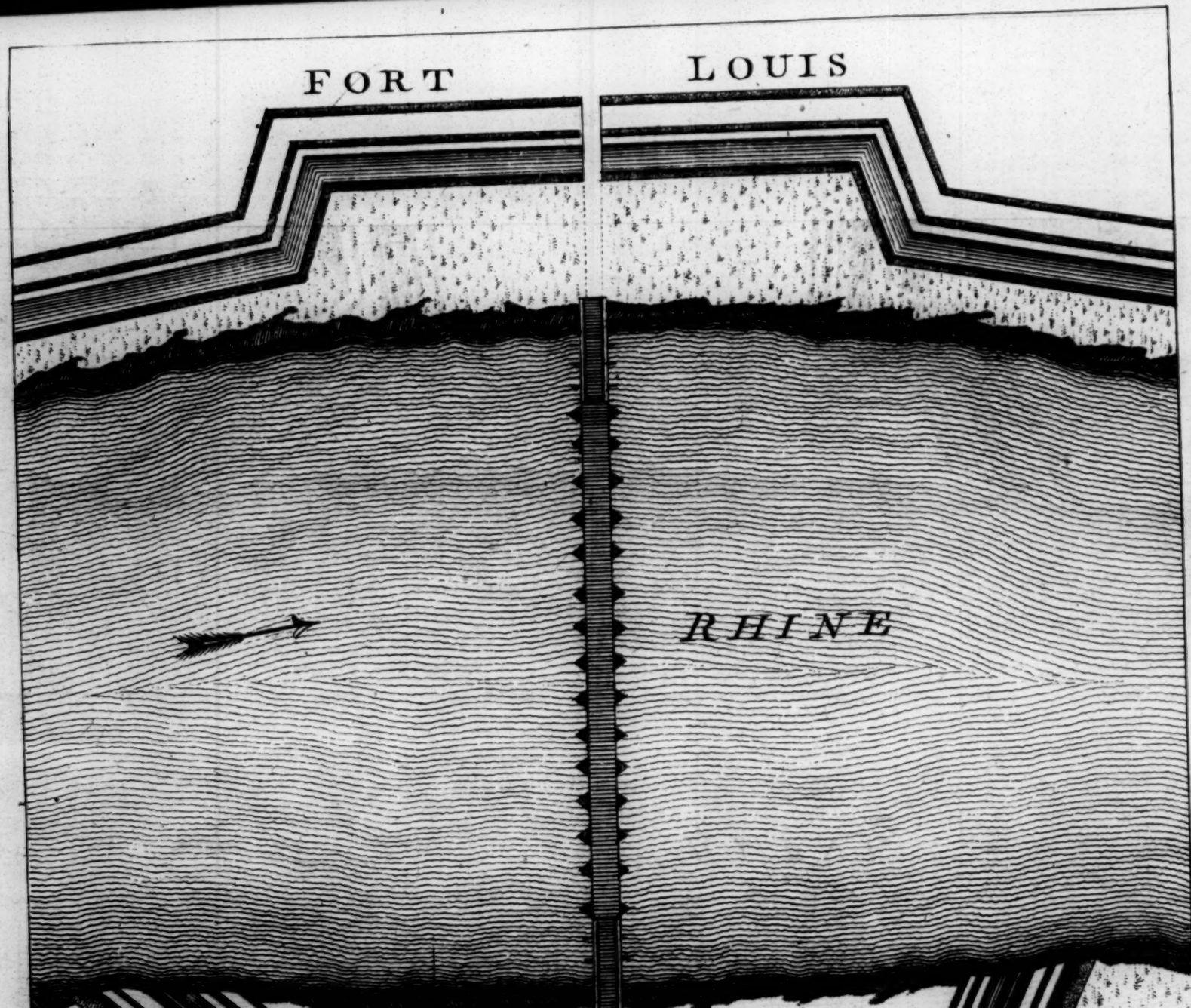
The exterior openings, for 9 or 10 feet from the ground, were at the ſame time walled up, to guard againſt fire, a common expedient of the enemy; and, as we did not want planks, I ordered the windows to be maſked, 6 feet from the floor, to cut loop-holes in them, and in the doors.

Theſe were my general precautions; the top of the little barn, and the walls of the great one were of good maſonry, and our breaſt-works defended this front pretty well, the only one eaſy of acceſs.

The ſide next the river, was incloſed with high ſolid walls, acceſſible only on the ſide oppoſite the bridge, and flanked by the bog-houſe, the tower next to it, and the breaſt-work adjacent to the tower: there was nothing to apprehend in the rear, and the ſides of the brew-houſe were carefully built on a ſteep rock.

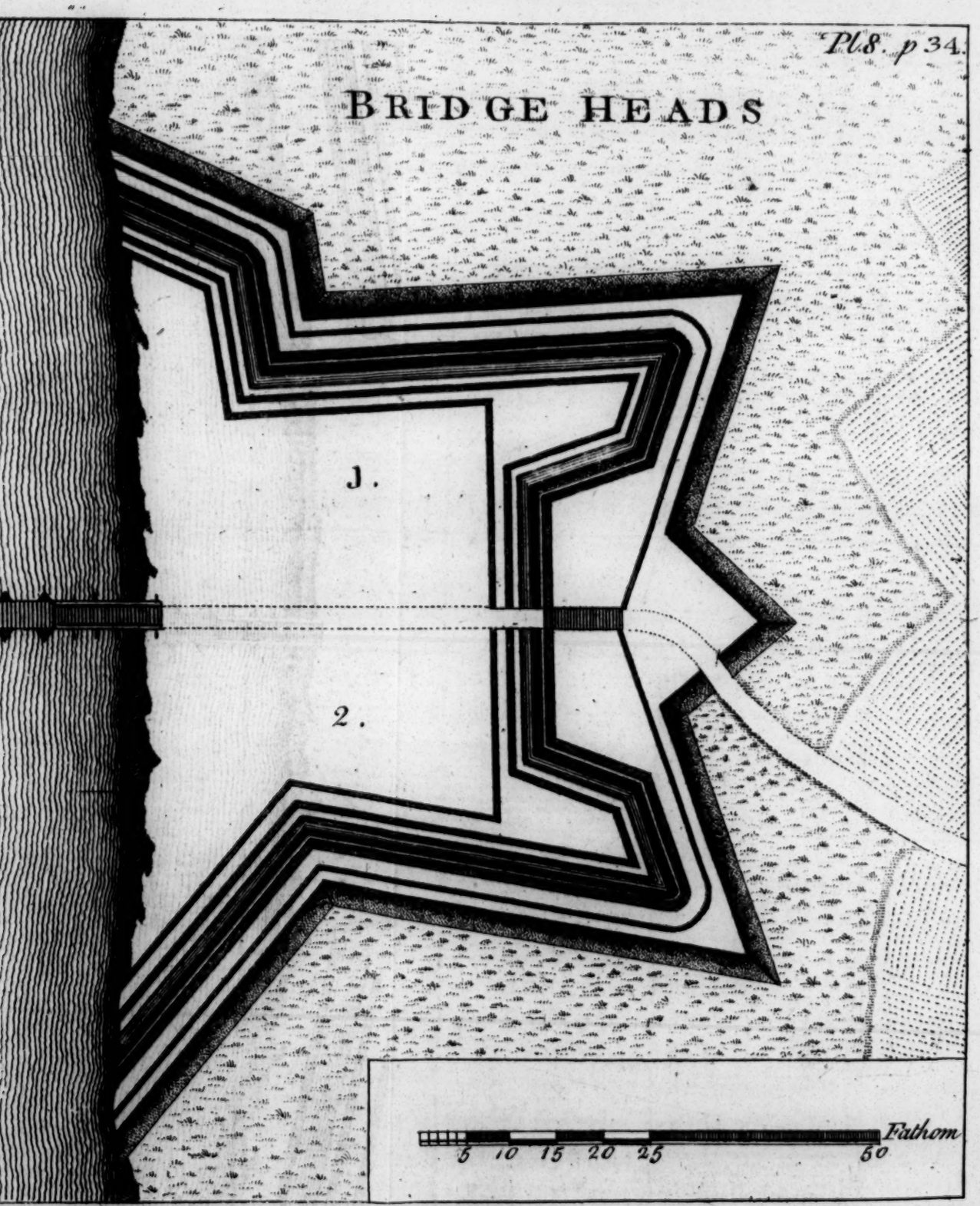
From thence to the pavilion, and from the pavilion to the little barn, the wall was from 6 to 7 feet high, along which we threw up a banquet: this ſide being weaker than the reſt, I ordered ſome loop-holes to be made in theſe buildings: from the brew-houſe to the pavilion, the hill is very ſteep, but of an eaſier aſcent

after-


FORT
LOUIS
RHINE

Pl.8. p 34.

BRIDGE HEADS



afterwards: the garden on the outside was enclosed by planks nailed to posts; I ordered it to be pulled down, also a dry stone wall 3 feet high, which parted the terrasses, and would have served the enemy for a parapet, by kneeling on the ground: these 2 terrasses I ordered to be made into a glacis, and every thing cut down that might obstruct our view.

The little barn, with which I shall finish the description of the inclosure, was certainly the most dangerous place, because 3 of its sides were of wood, and I was afraid, that if the enemy set fire to this, it might communicate to the great one, which was much higher, but covered with shingle, or cleft wood.

In my report, I proposed to pull it down, and close that space with a breast-work of the same construction as the rest, and turned so as to flank the adjacent parts; I should have done it of my own accord, but the design being to make this castle a magazine of forage, we were obliged to preserve places proper for concealing it from view of the enemy, since we could not keep them at a proper distance: I therefore supported a parapet of well beaten earth, by the wall of the garden, and where the slope would not permit that, I doubled it with a brick wall, built with clay, instead of mortar.

If I have explained myself clearly, it will appear, that the side of the garden was the only place that could be forced without cannon; and if the enemy had got over this wall, which was almost intire, I will venture to say they could not advance much further.

By raising a new breast-work on the side of the court, and opening some old doors, I had a free and sure communication through the stables, from the castle to the great barn, and its breast-work; it was possible to prolong this communication even to the brew-house, by a row of palisades, but that was a considerable encrease of work; a wall must also have been broke through, which was not without its inconveniency, and the brew-

houſe high and ſolid built, was in a very good ſtate to do without that aſſiſtance.

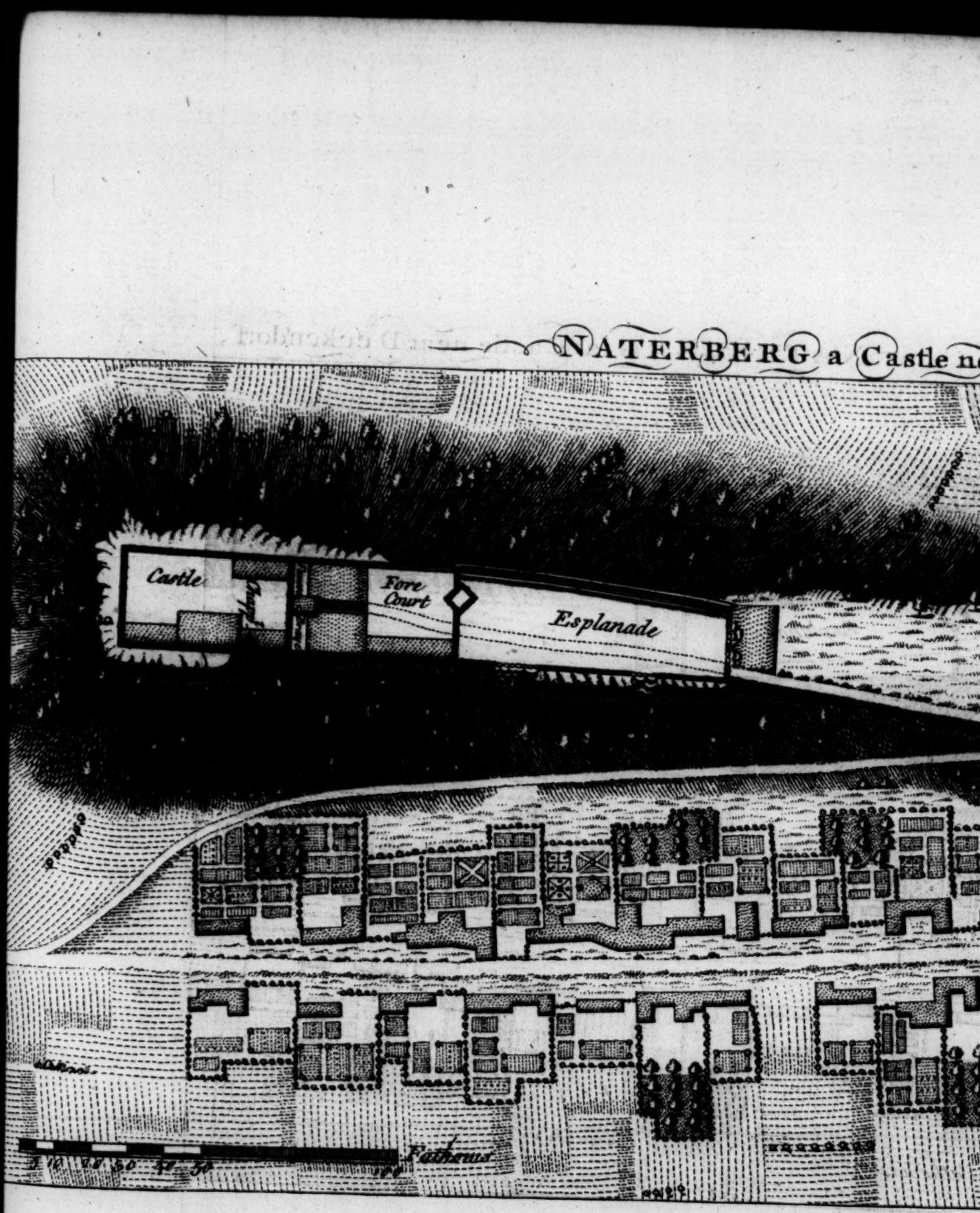
The windows and doors of the buildings being ſhut up to a proper height, and loop-holes made in them, it is ſufficient to caſt an eye on the plan, to be convinced, that the moſt reſolute enemy, could not keep their ground in the court, croſſed by ſo many fires.

V. A ſuccinct account of what paſſed a few days after, will better juſtify theſe precautions.

The 9th of the ſame month, in the afternoon, this caſtle was inveſted by about 800 men, from the garriſon of *Paſſau*, and the camp of *Mr. Kevenhuller*, among them were 400 grenadiers, ſome pandours and huſſars.

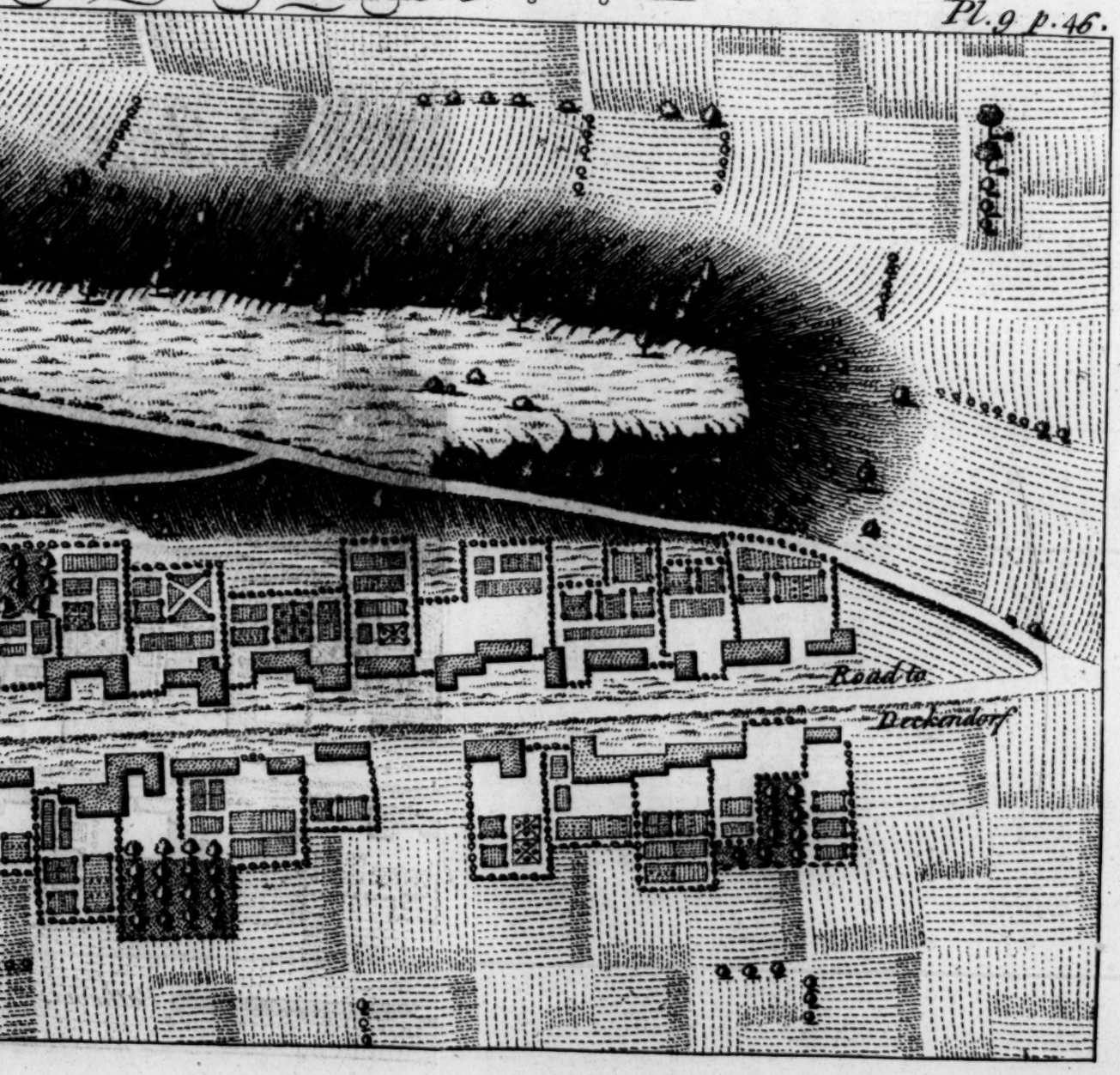
M. Darmeville, captain, commandant of a battalion of *Picardie*, held this poſt with 50 men, the independent company of *Regen*, and 80 dragoons of that of *Jacob*, who, being priſoners of war, were of no ſervice: the *French* commandant was oft ſummoned to ſurrender on honourable conditions; there alſo came an hoſtage to him, that he might ſend and reconnoitre the number and kind of troops by which he was inveſted. *M de Pouſſac*, captain in the regiment of *Normandy*, 1 of the detachment, was charged with this commiſſion: he found the 400 grenadiers behind a hill, but neither this or the confuſion of ſo many horſes in ſo ſmall a place, or the fear of the forage, ſcattered up and down the court, could damp the reſolution of theſe officers.

The ſight of the breaſt-work, which almoſt covered the front, made that ſide appear not eaſy of acceſs; the enemy therefore attempted the attack oppoſite the mill, which they burnt; their deſign was likely to climb up under cover of the brew-houſe, and ſlip along the ſurrounding wall, but finding the ſlope ſo ſteep, and the pavilion loop-holed, they quickly turned to the weakeſt ſide, viz towards the garden, where they had but 1 of theſe obſtacles to ſurmount. The beſieged, without the leaſt hurry or confuſion, never fired but in good time, and by order of the commanding officer;


NATERBERG a Castle n
Castle
Fore Court
Esplanade
Fathoms

Castle near Deckendorf.

Pl. 9 p. 46.





ficer; they killed ſome pandours, who, ſupported by their ſmall arms, attempted to ſet fire to the little barn in the night, with torches fixed at the ends of long poles. This ill ſucceſs diſcouraged the reſt; and finding they could neither ſet fire to the building, or diſorder our troops by their frequent diſcharges, they retired at 1 in the morning, to ſome diſtance, to conſider what method they ſhould take to ſucceed.

The thing was difficult without cannon, and *M. Saxe*, who had taken the command of the army, the day of the attack, did not give time to bring any. This general being informed of what paſſed, ordered a general forage, the next day on the left, where he marched in perſon: under this pretence, he detached, by different roads, 2 corps of infantry and dragoons, who diſengaged this poſt, and would certainly have either taken or deſtroyed the 800 men who attacked it, if too much ardor had not prevented their ſtrictly conforming to orders, of not appearing, but all at once, to cut off their retreat.

VI. Were my deſign only to give my own ideas, and treat of works of this kind, which I have executed, perhaps I ſhould have no more to add; but as my view is different, I ſhall conclude this chapter with ſome obſervations, chiefly drawn from an author, who is more explicit on this ſubject, as he had frequent opportunities of experiencing them.

1. *M. de Folard*, the only 1 who has wrote on this head, prefers walls of brick, and even the thinneſt of them, to thoſe of ſtone, as cannon only makes holes in them; and in ſtone, where it makes a breach, the ſplinters do great miſchief.

2. He recommends carefully to guard againſt fire, and conſequently, if the building is covered with thatch or boards, to pull down the covering and burn it immediately, leſt it aſſiſt the enemy in annoying you; as to the boards, they will always be of uſe.

3. He propoſes to ſtop up the door, eſpecially if it be large, with a tree or two, with all their branches cut and ſharpened at the ends, which he ſays, is better than the beſt barricaded door. This has certainly a good effect, but I do not ſee, why he would rather have the door open, as he afterwards mentions, than to have loop-holes in it: he ſays nothing of the windows.

4. He would have the loop-holes below, 3 or 4 inches wide, and 7 ½ or 8 feet from the ground, that the enemy may not fire through them, and about 2 or 3 feet diſtant from each other, that they may not get to the roof, without being expoſed; above all, he recommends to pierce the angles.

5. Beſides theſe loop-holes, he propoſes others below, under the intervals of the upper ones, and only 1 foot from the ground, digging a trench 6 feet broad, and 3 deep, 2 ½ from the wall withinſide. By this means you diſcover the legs of the aſſailants, which when near, cannot be ſeen from the upper: this is an excellent thought; I would only recommend that they be even with the ground, and not more than 6 inches high: the trench need not be deeper, becauſe they may fire kneeling. The banquets of the upper loop-holes muſt in this caſe be planks.

6. Leſt the enemy ſhould gain the roof, which we here ſuppoſe tiled, it muſt be ſcaffolded, ſo as to be defended by ſome holes made in it.

7. He adviſes to provide a number of ſtones, to throw down, eſpecially at the angles, where the enemy will attempt to ſap.

8. If for want of men, or other means, you are obliged to quit the lower part, he recommends, to uſe all poſſible means to keep the enemy out of it; therefore holes muſt be made in the upper floors, eſpecially towards the doors, to fire down through: this *M. de Saxe* practiſed, when he defended himſelf a whole night in a country inn, with 18 men, againſt a detachment of

of 200 dragoons, and 600 *Poliſh* horſe, who could neither force nor take him, tho' wounded.

9. When you can only poſſeſs part of the upper rooms, *Folard* propoſes to break up the floors of thoſe you abandon in many places, at leaſt before the doors, a little more than their breadth, that this opening may ſerve as a ditch; but it is neceſſary to have an eye below, leſt the enemy get thro' them by ladders.

10. Laſtly, if the doors are ſlight, and if they attempt to break them with hatchets, he would have you retire to ſome diſtance, and keep firing at the place from whence the noiſe comes: it was thus practiſed in *Italy* at the defence of the caſtle of *Bouline*, 1705, celebrated by this action.

The reader muſt perceive, that the chief part of theſe rules agree with the different articles of this chapter, by adding what I have ſaid on each in particular, little more can be deſired on this ſubject. I ſhall however add ſome reflections on the attac, an object always to be had in view, when we are treating of the defence.

Suppoſing the poſt in condition, ſufficiently provided with troops, and that the enemy have no cannon, they are then reduced, as *Folard* obſerves, either to ſcaling the roof, undermining the walls, or making a breach with a beam, ſuſpended between four poſts like a ram; now it appears impoſſible to me, that any of theſe means can ſucceed, as long as ammunition laſts, or the defendants preſerve their ſenſes.

When you are obliged to abandon the ground-plot of the building, there is nothing to fear, in my opinion, but fire and ſmoak, things very difficult to guard againſt; it ſhould therefore be defended as long as poſſible.

If the aſſailants have ſome cannon of 6 or 8 pound ball, and theſe placed out of reach of muſket-ſhot, it does not ſeem prudent to contend ſo obſtinately againſt a fire you cannot anſwer, unleſs you know aſſiſtance is

near, or when ordered to defend it to the laſt extremity.

It muſt be remembered to defend the doors, as much as poſſible, to flank the walls, and to make the little *Machicoulis* of wood I mentioned, and to collect a number of ſtones; but being more apprehenſive of fire than ſapping, I would rather have a magazine of water.

Observations on the third Chapter.

In the courſe of a campaign many circumſtances may occur, where the ſagacity and knowledge not only of engineers, but alſo of every officer who may command a party, may be diſplayed to his reputation, and the advantage of the public. When an army is not ſtrong enough to venture a battle, or ſome other reaſons require it to be upon the defenſive only, poſts are to be taken to reſtrain the enemy from ravaging the country; parties are ſent to fall upon convoys or ſtragglers in foraging; and to ſeize all opportunities to defeat the enemy's ſchemes, which ſucceſsfully done, oft reduces a ſuperior enemy to an equality before the end of a campaign.

It is therefore neceſſary to make uſe of country-houſes, church-yards, or villages, in caſe of being overtaken by a ſuperior party of the enemy, and to barricade or fortify them by ſome ſmall work to gain time, either to be ſuccoured, or eſcape in the dark. This the author has endeavoured to explain by ſuch examples in which he was chiefly concerned, ſo clear and inſtructive, as requires very little to be ſaid on the ſubject. I ſhall only obſerve, that in the example cited of M. *Saxe*, when he defended a houſe with 18 men againſt 200 dragoons and 600 horſe; there is to be added, when it was dark he ſallied out of the houſe, his men having their bayonets fixed, with order not to fire, by which he eſcaped and got into a wood, where he could not be purſued.

page 40

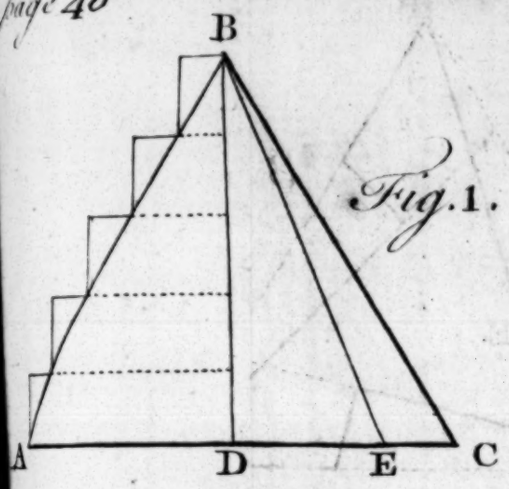
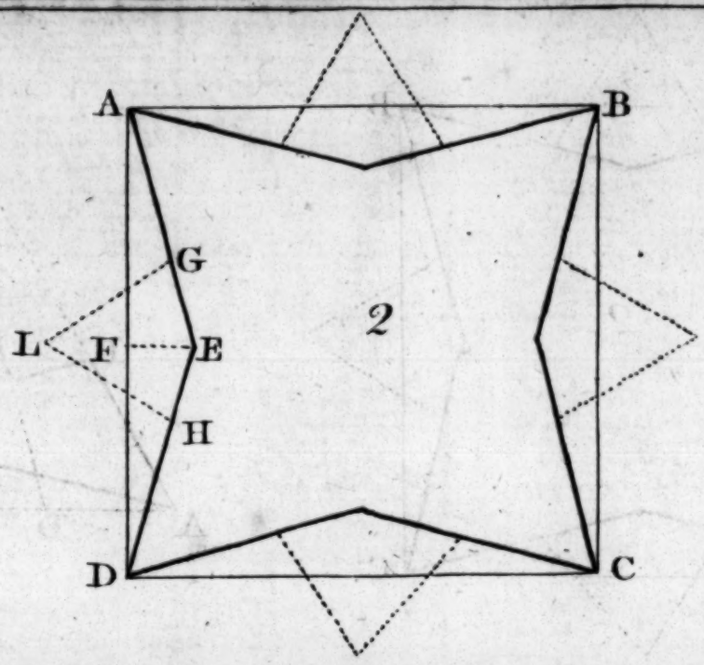
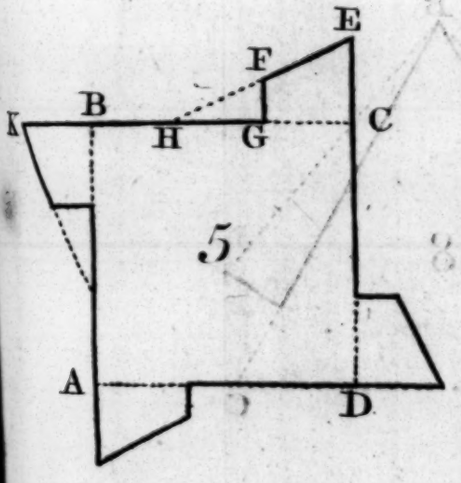
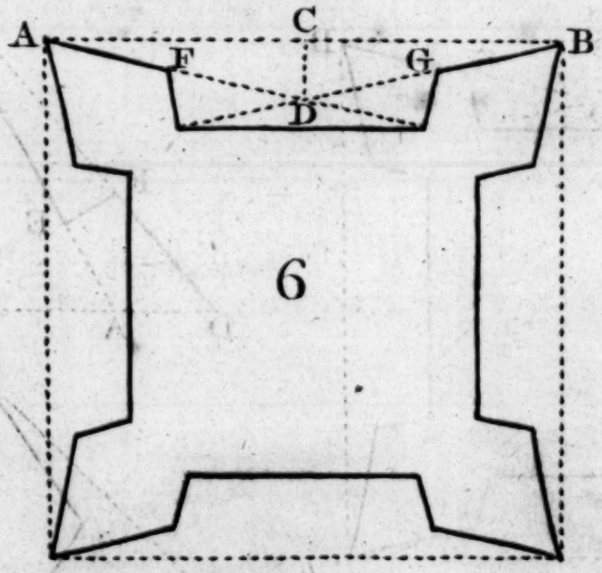


Fig. 1.

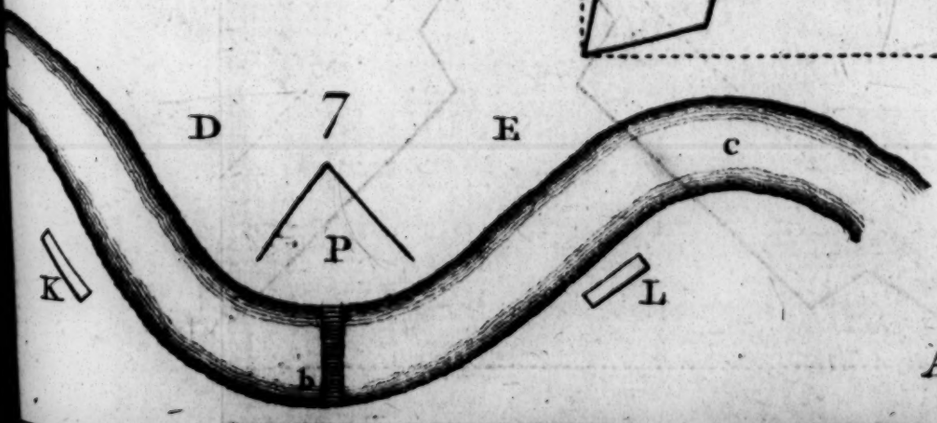












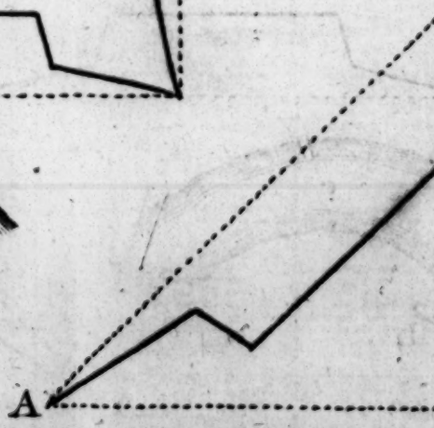
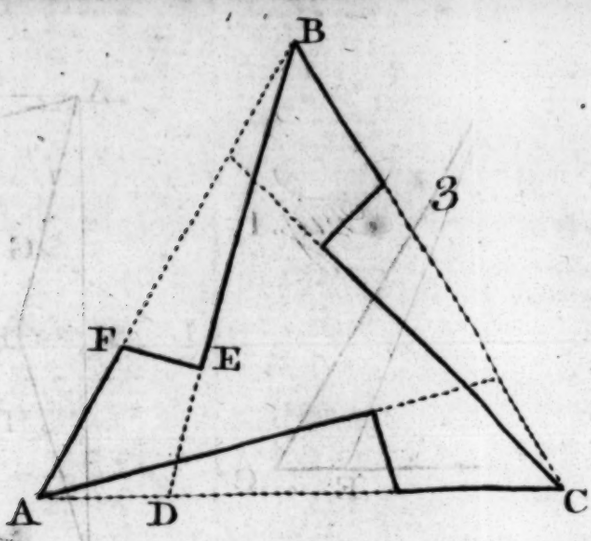
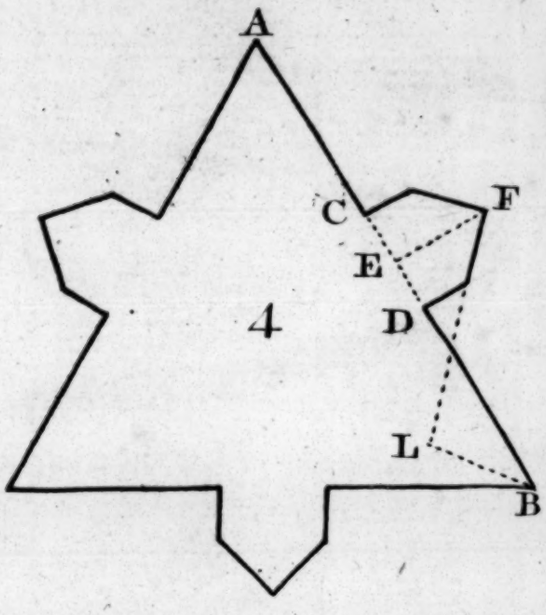
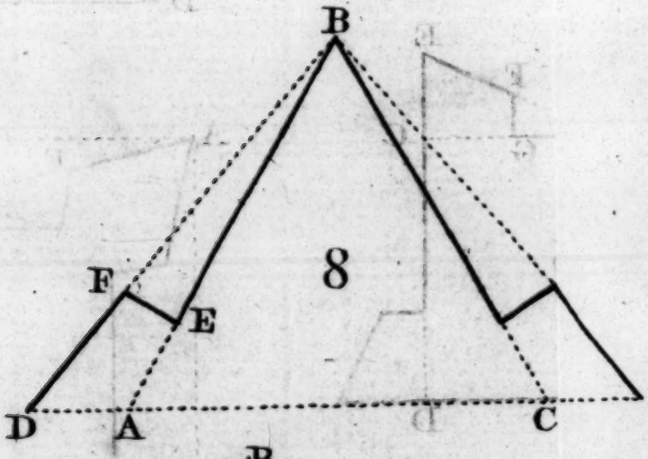
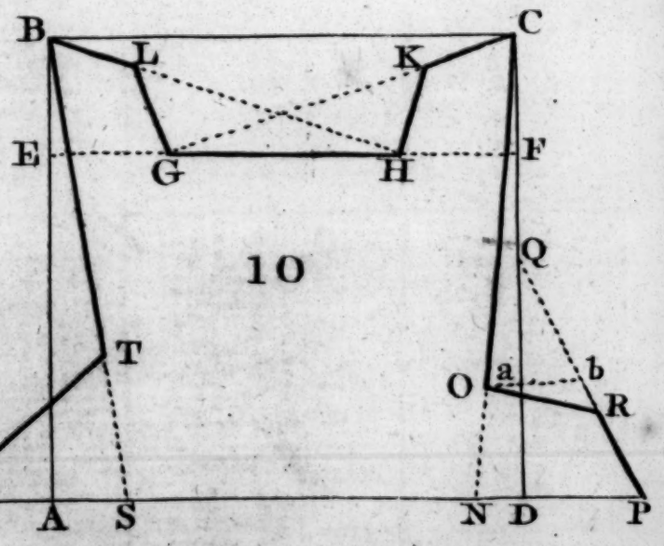


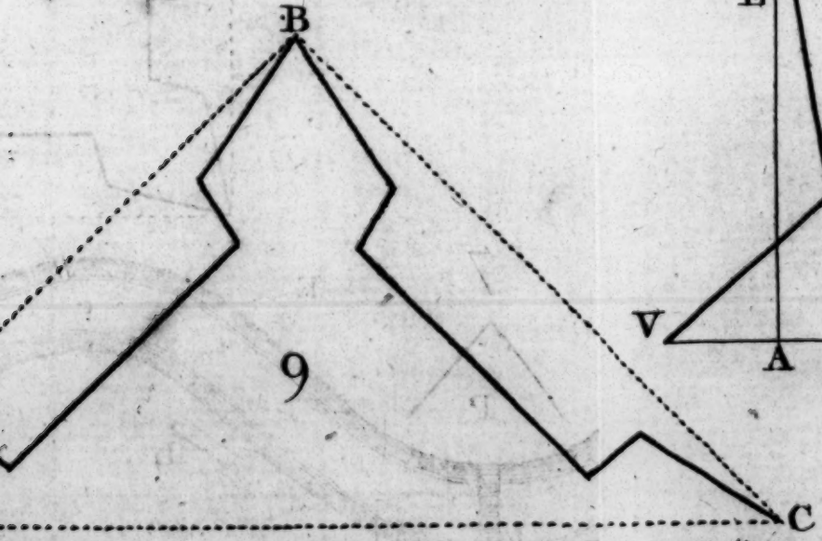
Plate A.

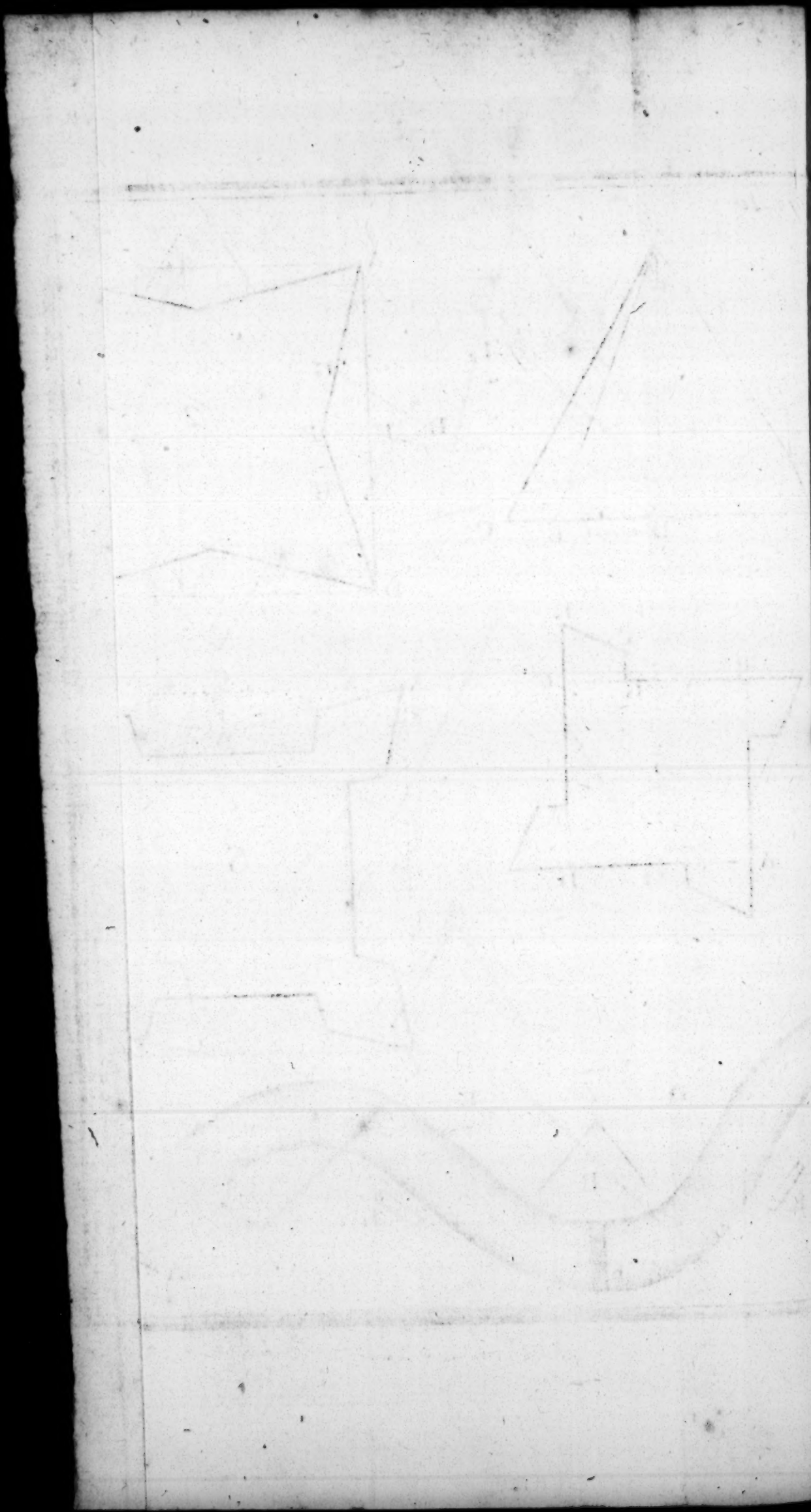












In the laſt war in *Flanders*, an enſign of ours was placed in a village, with a party of men, thro' which the *French* intended to paſs with a conſiderable detachment; it happened luckily that there was a young engineer with this party, who adviſed the enſign to have the principal ſtreet barricaded, and to throw up an intrenchment croſs the road at the entrance of the place; which being done, and men placed there; when the *French* ſaw the alacrity and good diſpoſition of our troops, went another way, imagining that there was a much greater force than appeared; and the enſign was rewarded with a company for his behaviour, though in reality the honour was due to the engineer, who adviſed him to this bold ſtep.

CHAPTER THE FOURTH.

I. *Fortifying ſmall towns and other conſiderable places.* II. *Advantages and diſadvantages in regard to the diſpoſition and conſtruction of the houſes.* III. *Inconvenience of their great extent.* IV. *Means of correcting it in certain caſes.* V. *Inconveniencies almoſt always inſurmountable.* VI. *Places to be intrenched for a day of battle.* VII. *Communications to be eſtabliſhed from a poſt to a bridge; firſt example.* VIII. *Second example.*

I. VARIOUS circumſtances, ſuch as the neceſſity of keeping an enemy at a diſtance, preſerving communications, ſecuring from ſurprize a body of troops in winter quarters, or quarters of refreſhment, often oblige to fortify larger places, than thoſe already mentioned.

An engineer muſt, in this caſe, carefully examine the ſituation of the place, the nature of its environs, the diſpoſition and conſtruction of the buildings, the extent of their circuit, what troops it can contain, viz.

what

what number can be encamped or quartered in it, according to the ſeaſon.

He muſt examine at what diſtance the neareſt woods are; if the roads are good or bad; the number and kinds of workmen and tools, carts and beaſts to draw them, on which he can depend; what aſſiſtance he can procure in the place, and what near at hand.

Theſe attentions are all equally indiſpenſable; a village, and even towns commanded by eminences, ſuch as *Donavert* and *Deckendorf*, are always very bad poſts. A precipice at all times, and, except in great froſts, a river with ſteep banks, a place that can be laid under water, a deep moraſs, a low ground and full of ditches, are always advantages, if they are at a convenient diſtance from any part of the intrenchments: ſo much of the intended work is thus leſſened, and a very eſſential point gained; on theſe occaſions, there is ſeldom any other workmen than thoſe to be had from the troops, deſigned to guard the place, and their number is commonly regulated by what it can obtain.

When a place is intirely ſurrounded with an intrenchment, a ſingle ditch, if it is not deep and full of water, is ſeldom ſufficient to ſtop an enemy: it is therefore oft neceſſary, to palliſade and fraiſe; beſides, there muſt be bridges and barriers which require wood, carriages, workmen and tools.

II. However important ſuch aſſiſtance may be, I is ſometimes obliged to do without it: it may in part be ſupplied, by the means I ſhall ſpeak of in treating of the conſtruction.

There are places ſo advantageouſly ſituated, that they ſeem intended to be intrenched: ſuch are thoſe on the brow of a ſteep hill, or which occupying the bend, or conflux of rivers not fordable, are naturally inacceſſible for the greateſt part of their extent.

On the contrary there are ſome, which, on account of defects not to be remedied, ſhould abſolutely be rejected, as incapable of any defence; among others, are

thoſe

thoſe commanded by adjacent heights, from which the parts liable to be attacked cannot be covered: this maxim, tho' evident in itſelf, yet regard muſt be had to attendant circumſtances: the part commanded, for example, may be inacceſſible, and on the ſide expoſed to the attac, covered by houſes; in that caſe, ſuch a place may be defended, ſince ſome little poſts are ſufficient in thoſe places that are commanded; which may eaſily be ſheltered and ſecured from danger, and preſerve their communication by ſome adjacent building.

Thus I propoſed to eſtabliſh a poſt in the church-yard, of the ſuburbs of *Deckendorf*, ſituated at the foot of a hill, almoſt perpendicular, but partly covered by the church: the intent was only to contribute to the preſervation of a communication from the ſuburbs to the town, and from the town to the *Danube*.

III. A village ſituated in dry and even ground, ſuch as affords no advantage, is ſeldom proper for the uſe we are ſpeaking of.

What is here eſteemed a great defect, is, generally ſpeaking, a deſireable circumſtance in fortified places; but tho' the rules of fortification may hold good in both caſes, yet they are very different: in one, we work at leiſure, with all things neceſſary; in the other, the time and means are limited.

There is a neceſſity, therefore, of drawing from the ſituation ſuch aſſiſtance as may abridge the work; it is, as I have ſhewn, of various kinds; the diſpoſition and conſtruction of the buildings, ſometimes furniſhes the ſame advantage as a good ſituation.

When I arrived at *Donaſtauf*, in *September*, 1742, I found ſome officers of the two battalions quartered there, employed in increnching that town. The caſtle, from which no other aſſiſtance could be expected, for want of loop-holes and ſcaffolding, covered part of it by its height: a hill of great extent, incloſed by a wall, and the contiguous houſes, greatly ſhortened the work. I was otherwiſe employed, and had only 1 engineer

gineer with me: I adviſed them, and they ſucceeded ſo well, that in a few days, having received advice that the enemy ſeemed diſpoſed to attack them, they found themſelves in a good poſture of defence.

When the houſes, though ſeparated in many places, do not form a very long figure, and as in large towns, are built and covered ſo as not to fear fire, they may be uſeful, by making loop-holes in them, and in the intervals throwing up ſome intrenchments, that may flank each other, or be flanked by thoſe buildings which project pretty far; it was thus I propoſed for one part of the ſuburbs of *Deckendorf*.

If the houſes are of wood, as in *Bavaria* and *Bohemia*, or of earth and thatched as in *Flanders*, they are only fit for habitations, and are otherwiſe more dangerous than uſeful.

IV. The greatneſs of the circuit, adds to this inconveniency, and in regard to circumſtances, ſometimes forms an inſurmountable one. I found myſelf in this caſe at *Pilſting*, a town ſituated on this ſide the *Iſer*, half a league from *Landau*. Its poſition made it propoſed to quarter ſome troops there, and was reſolved upon, ſo ſoon as it was known that the *Auſtrians* had taken poſſeſſion of it.

I was ſent from the army the 14th of *November*, that is, two days after the ſurrender, and having received orders to intrench the town, I carefully examined it, and quickly diſcovered moſt of the defects I have mentioned; it is not commanded on any ſide, its environs are alſo croſs cut with ditches and drains, and almoſt throughout marſhy: but the winter approached, and is very long and ſevere in *Bavaria*; therefore theſe advantages of nature, that ceaſed on the firſt froſts, could not be relied on: beſides, of 70 houſes which were in *Pilſting*, 7 only were of maſonry, the reſt wood.

Plate XI.

We

We were under a neceſſity of intrenching it entirely, or at leaſt to fortify its bounds by ſuch works as we ſhall treat of, which was not even practicable.

Thi new difficulty proceeded from the houſes being moſtly ſeparated by yards and gardens; their circumference, tho' they formed 4 different ſtreets, could not be reduced to leſs than 850 fathoms.

I perceived this place would only quarter 1 battalion, which was neither ſufficient to fortify or defend it.

This reaſon alone was unanſwerable; I ſhould alſo have had great difficulty to get as many paliſades as neceſſary; the *Rindal*, a little wood, 1 league off, towards *Straubing*, being entirely cut down, we ſhould have been obliged to fetch them farther off, and the few horſes and oxen, which the *Auſtrians* had left, were inſufficient, eſpecially with bad carriages and worſe roads.

Tho' the church-yard was ſpacious, and encloſed with a good wall, and it was eaſy to make a communication with 3 houſes of ſtone, and 2 of wood, which joined it, the enemy not being able to get thro' thoſe of wood ſoon enough, if they did ſet fire to them, nor to leave us ſufficient time to ſupport, or at leaſt to barricade the opening they ſhould make; and as this particular poſt, good only for a laſt reſort, decided nothing in our favour, as we could not make uſe of it without abandoning the town, the ſick, the ſtores, and the baggage, I did not heſitate to conclude, that *Pilſting* was incapable of being entirely fortified.

V. There are circumſtances, which oblige to SACRIFICE the intereſts of private people for the publick good: there are even CRUEL wars, where the neceſſity of the repriſal forces in ſome meaſure the DEVASTATION which it authoriſes; very terrible circumſtances, and which an engineer ſhould never PRACTISE without particular ORDERS, and which he ſhould very ſeldom demand.

It is evident, I would ſpeak of thoſe occaſions where the uſeleſs parts are deſtroyed, to preſerve with much

leſs

leſs work thoſe that are uſeful. Had we been in this caſe at *Pilſting*, and that part of the town moſt compact together had been ſufficient for our purpoſe, all would have been eaſy, at leaſt very poſſible.

By levelling the houſes, which extended along the roads of *Straubing* and *Deckendorf*, the circuit would be ſhortened more than 200 fathoms, that is, about a 4th, and very little quarters would have been loſt.

That was a great deal, yet incloſing the remainder, ſeemed too conſiderable a work for 1 battalion, weak as they always are at the end of a campaign, and puſhed perhaps, by the unexpected march of the neighbouring troops, to haſten the intrenchment: on theſe occaſions we may have recourſe to the expedient I ſhall here propoſe.

Having determined the figure of the incloſure in the moſt convenient manner, raiſe at the angles redouts in the form of baſtions, whoſe fire croſſing in the intervals, reciprocally graze the faces of theſe little works.

Plate XI. The plan will explain my deſign: 5 ſides of the exterior polygon are of 100 fathoms each: they may be of 120, or even 130. The perpendicular is 1 12th of the ſide; the faces are 12 fathoms, and the flanks perpendicular to the lines of defence.

The 6th front is near 150 fathoms, but it is better defended, as the faces are grazed by the wall of the church-yard, and the 2 parts of this wall, the moſt projected, are alſo grazed by the flanks of the adjacent Baſtions.

This figure is no more than a polygon fortified after the uſual method, except that there are no curtains. The *Redans* would have been of more extent than theſe redouts, which are ſubſtituted in their room; I therefore ſave all the curtains, viz. more than 420 fathoms of work; for reckoning 50 fathoms for each redout, the 720 fathoms, which were to have been made, are reduced to 300.

As

As to the defence, 50 men in each redout, as many in the church-yard, and the reſt of the battalion drawn up with the grenadiers, in the propereſt place to ſupport where neceſſary, are ſufficient.

I don't know that this ſcheme was ever executed, or even propoſed: yet it is ſo plain, that I cannot think it new; whether it is, or is not, it may be uſeful in certain caſes.

Having given an account of its advantages, it is proper to expoſe its defects: in a quarter not incloſed, ſuch as this, the ſoldiers may ſtraggle in the night, the peaſants have dangerous communications, and a reſolute body puſh thro' the intervals.

The commandant, or engineer, charged with the project, ſhould examine if he can do better, in regard to time, and the number of workmen: in this manner a poſt is quickly put into a ſtate of defence, which, according to the common method, cannot be done but with a vaſt body of men: this advantage is eſſential; beſides, if we have time, or ſhould haſten a little more, nothing prevents our perfecting the encloſure with a parapet of earth, or by trees, or any other kind of barricades.

VI. Whatever number or variety of expedients experience and imagination may ſuggeſt, yet places are ſometimes found in a plain, as at the foot of mountains, which we can turn to no advantage.

The greateſt part of villages are thus ſituated; the houſes commonly extend along 1 or 2 roads that run through them, the reſt is only courts, orchards, and gardens, encloſed with very bad hedges, narrow ditches, walls of mud, dry ſtone, or wood, which renders the circuit exceeding great, in proportion to the number of houſes: ſuch is *Schleitel* on this ſide the *Louvre*, only compoſed of 2 rows of houſes in right lines, and ſeparated; and is at leaſt as long as *Strasburg*, including the citadel.

When

When houſes are built, or covered with combuſtible matters, it is another inconveniency: I found them all united at *Biſchoffmais*, a village, 3 quarters of a league this ſide *O* caſtle; and deſigned alſo for a magazine of forage. The church-yard, the ordinary reſort in like caſes, could not defend the barns, for its diſtance; beſides, being narrow, and ſurrounded almoſt every where with houſes of wood, which commanded it, I ſaw that the enemy had it in his choice, either to fire on, or burn thoſe that defended it.

I examined the village, according to my orders; but I propoſed nothing for its defence, it appearing impoſſible to me to do any thing: ſo that the lieutenant, which was left there with 30 men, owed his ſafety, and that of his men to his own ſkill.

During the attac of the caſtle, ſome men having appeared to reconnoitre it, he took the only advantage to be taken, which was to retire into the church, barricaded its avenues, and made loop-holes with ſcaffolding, the uſe of which I had ſhewn him: chance favoured his precautions, and ſaved the magazine; 20 volunteers, who were eſcorting a ſmall convoy of bread, going to *M. de Graſſin* on the frontiers of *Bohemia*, finding the roads ſtopped up, joined him; they had 2 drummers with them, which the officer made good uſe of; at the uſual hour of beating the retreat, he ordered them to beat that of the infantry and dragoons at the ſame time, and it was this ſtratagem, perhaps, that made them poſtpone attacking this, till after the taking of the principal poſt, which, as I have ſhewn, could not be forced.

VII. Thus the greateſt difficulties to be ſurmounted in fortifying ſmall towns and villages, are the diſadvantages of a commanded ſituation, of an incloſure of great extent, and the dangerous conſtruction of the houſes, which will not permit to uſe them in the defence.

We have hitherto ſuppoſed the moſt ordinary caſes, that is, a detached poſt or quarters to be ſecured; there

there are others, where different circumſtances oblige us to be regulated by other maxims. As for example, the fortification of a village, intended for ſervice in a day of battle: whether it be advanced, or in the line itſelf, or on 1 of the wings, is immaterial, and often more uſeful than hurtful, that it be commanded, provided it be only in the rear.

The number of troops to be employed in it, not depending on what the place can quarter, the inconveniency of its great extent, and even of the combuſtible materials employed in its conſtruction diſappear; as the principal uſe of the houſes is to hide any neceſſary motions from the enemies ſight, all that may be hurtful muſt be incloſed, not regarding the number of workmen and troops ſuch works require.

What is moſt eſſential, and to be moſt regarded, in this caſe, is in my opinion, to have as large flanks as poſſible, becauſe there is not the ſtratagems or feint attacks, but the effort of a column to be reſiſted: to lay open the environs, by cutting down all trees, hedges, &c. within 2 feet of the ground, that the artillery may have the greateſt effect poſſible, which is here abſolutely neceſſary; to incumber the ground before it, and on its flanks, that the enemy may not advance without being broke; and to level all in the rear, that the troops may return to the poſt with force, and in good order, ſhould neceſſity require it.

When the village terminates the line, the intrenchment muſt be lengthened by a return gibbet-wiſe, and the expoſed ſide incumbered, to guard againſt being flanked by the enemy.

A favourable ſituation, eſpecially, if it juſt riſes ſo as to command the parts to be battered, is always a great advantage: many circumſtances, which in other caſes are conſiderable obſtacles, are not here to be regarded, and vaniſh by the means we have of ſupplying their defects.

This article is more eſſential to an engineer than is imagined: few battles have been fought without ſuch poſts, and that of *Fontenoy* is an example of what importance they may be.

VIII. When the town or village is advanced before the army, and at ſome diſtance from a river, and conſequently from a bridge, the town muſt not only be fortified, but the paſſage to the bridge muſt alſo be well ſecured, that ſo eſſential a communication, as well for ſuccours as a retreat, may not be cut off.

I was twice intruſted with this charge in *Bavaria*; *M. de Balincour*, poſſeſſing the riſings which commanded the openings of *Dingelfling* beyond the *Iſer*, the enemy being maſters of *Landau* only 6 days, abandoned it; I received orders to put that place into a ſtate of defence as ſoon as poſſible.

It is ſituated on the brow of a little hill, of which it occupies the whole breadth up to the top: 2 gates, 1 below, another above, divide the ſurrounding wall, almoſt into 2 equal parts: on the right of the entrance of that ſide, next the river, the wall is low, and no more than 2 feet broad, it almoſt every where joins the houſes; but it is not commanded, and the ground on which it is built is ſo ſteep, as to be impracticable to paſs it. I obſerved that the floors of the houſes might ſerve for banquets to the loop-holes, and that it was eaſy to build wooden ones in the courts, yards, and ſuch like places I found round the wall.

On the left, the wall appeared in better condition, except in 1 part, where it was propped up, and conſequently muſt be intrenched; it was between 4 and 5 feet thick; a little roof, which covered the wall in places where the houſes did not touch, was a protection from the riſing grounds, and there needed only ſome ſlight repairs, and to break through ſome houſes, to have a communication from 1 gate to another: this ſide has a broad and deep ditch with a ſteep ſlope.

There

There were breaſt-works and folding-gates, with their barriers at the 2 gates. The incloſure, ſpeaking in general, had neither towers nor flanks; but I found they might ſoon be made, and at little expence, by a method I ſhall ſpeak of in treating of the conſtruction; ſo that by this aſſiſtance, abſolutely neceſſary againſt ſcaling and ſapping, I flattered myſelf, I ſhould in a few days put the body of the place into ſuch a ſtate of defence as not to be forced without cannon.

The ſuburb is almoſt of as great extent as the town; I could not avoid preſerving them, as well for the neceſſity of quarters at that ſeaſon, as to incloſe the ſpot where a bridge was to be built, in the room of that burnt by the enemy. This ſuburb was commanded by a conſiderable riſing very near, reſembling a truncated cone, on the top of which was a large chapel. I propoſed to poſſeſs theſe eminences by redouts, which ſhould communicate with the ditch of the place, and to raiſe ſome others at proper diſtances, in the flats of the *Iſer*, to be joined together by a little parapet, ſurrounded by a wet ditch. Theſe precautions were ſufficient on this ſide; on the other, a ſimple intrenchment, well palliſaded, would incloſe the ſhort ſpace between the ſteep hill and the river. This ſuffices to ſhow what may be done on ſimilar occaſions; it would have been the work of a very few days, but I had not time even to begin it.

IX. While the greateſt part of our troops were forming on the other ſide the *Iſer*, *M. Saxe* driving all before him that attempted by favour of the defiles, to oppoſe him in his march, advanced on the other ſide the *Danube*; it was reſolved to return to *Deckendorf*. *M. le Comte d' Aumel*, commanding in chief the engineers, ordered me, when I leaſt expected it, to join him; which I did the ſame day, returning by *Straubing* to *Ober-Alteich*, the general rendezvous, and from thence to *Pogen*, our particular quarter.

Our little army, which we then called the reſerve, chearfully embarked the 2d of *December*, on the *Danube*; (except the cavalry who took the common road) and though oft cloſely purſued by the huſſars, who drew up in order within piſtol-ſhot of the river-ſide, arrived at *Deckendorf*, a little below the ruins of the bridge we had burnt 3 months before, when we marched for *Bohemia*.

The enemy, ſurprized at our ſudden arrival, and by that rout, abandoned the place after ſome diſcharges of cannon; ſo that inſtead of being employed in 2d, at the ſiege, according to my firſt deſtination, I was to put this place into the beſt ſtate of defence.

This would have been eaſy, was it not for the heights, which rather plunged into it, than commanded it: it was ſufficient to repair the banquets of the body of the place, to renew the platforms in the towers; and in caſe of an attac, when the ſpot was once determined on, to raiſe on the right and left, from the principal wall, to that of the *Fauſsbray* intrenchments, with palliſades joined, and with loop-holes, and ready prepared, which would flank the troops with a croſs fire, who ſhould endeavour to force a breach, and which we in the interim would have intrenched and barricaded within.

As to the principal ſuburb, the proximity of the *paung*, and of the hill, otherwiſe ſo diſadvantageous, the ſituation of the church-yard, the great extent of the court of the parſon's houſe, and the incloſure of the capuchins, were favourable circumſtances.

Plate XII. I was charged with the town and plain, *viz.* to repair the body of the place, intrench the ſuburb, and preſerve a communication with the *Danube*. The plan will ſave me a tedious detail; I ſhall therefore confine myſelf to ſome notes on it, where it requires an explanation.

The intrenchment A at the head of the ſuburb was begun; it was covered by a redout, which could not be

be taken without being maſters of 2 others, and it preſented a much greater fire on the defile than could be oppoſed to it; though good againſt a ſurprize, it would be difficult to be maintained in a general attac, becauſe of the heights.

The church-yard B is a terraſs, raiſed 18 feet, and lined with a parapet of good maſonry, with large loop-holes: the church, and 2 rows of large palliſades, would have covered the party poſſeſſed of it, from the fire of the hill, tho' almoſt perpendicular: the little intrenchment C which flanks it, covered an old bridge, and incloſed a conſiderable number of houſes.

The intrenchment D (propoſed to ſupply this, ſhould the incloſure be found too extenſive, or the troops too much diſperſed in the different poſts) and that of F are deſigned to cover a communication, open from the place to the *paung*, as well by the gate of *Nider-Alteich*, as by the poſtern E, which I deſigned to make, when repairing part of the wall that was fallen down: dams were alſo to be made, to fill the river to the ſummit of its banks, that it might not be forded.

The direction of the works, which extend from the *paung* to the *Danube*, ſhew it is a crown-work, without curtains, where the left redan of the head of the bridge, forms a demi-baſtion.

The front was to have been defended by batteries placed on the other ſide of the *Danube:* the fire of the baſtion on the right, covers the gate of *Straubing*, and the little work at the ovens ſerved to keep the *Saiques* in awe, who might endeavour to get up again.

Suppoſing *Deckendorf* in a plain, it could not have been put into a ſtate of defence, and the communications preſerved, with fewer works; but *Deckendorf* and that part of the ſhore were commanded; theſe heights ſhould of neceſſity be occupied, and ſo as not to be diſlodged; but this was not only very difficult, but almoſt impoſſible in regard to circumſtances; yet we endeavoured it, becauſe it was an indiſpenſible point.

M. le Compte d' Aumale, traced the 3 redouts marked in the plan; they could not be better diſpoſed; but theſe poſts neceſſarily required a number of troops to poſſeſs and ſupport them, therefore he depended only on the ſtate regiments are in, at the concluſion of a long and laborious campaign, and our cantonment was ſufficient to furniſh the whole; but though the common time of ſickneſs was paſſed, thoſe that remained in health, 6 weeks after, that is, at the end of *January*, were inſufficient to guard the colours, much leſs to maintain a poſt ſo diſadvantageouſly ſituated; on which account, and the hardneſs of the earth, cauſed by an exceſſive froſt, we had only traced 1 part of the works, and even that, far from being perfected, was no more than begun.

I ſhall conclude this chapter, by obſerving, that the preceding examples, not only ſhew the manner of making uſe of old incloſures, to retrench ſuburbs, making bridge heads, and to ſecure communications; but alſo that an engineer, how diſagreeable it may be to be imployed in ſituations where art cannot rectify nature, ſhould arduouſly endeavour, to leſſen the evil which he cannot intirely remove.

Observations on the fourth Chapter.

Here the author treats the manner of intrenching poſts of a great extent, either to contain a conſiderable part of an army, in ſummer, or for winter quarters; or ſometimes to ſecure a large magazine of forage, or the heavy baggage of an army.

A poſt, ſurrounded partly by a river, and partly by impaſſable marſhes, may be eaſily intrenched, and defended by a few men, during ſummer, but cannot be maintained in winter; as the froſt would render the paſſage over the river or marſhes as eaſy as dry ground; it requires therefore, different conditions to fortify a poſt in ſummer, from thoſe of winter.

The

The moſt important attention of a general ſhould be, that of ſecuring his magazines of forage and proviſions, ſo that the enemy may not be able to deſtroy them, either by ſurprize or open force: they ſhould be as near the army as poſſible, that the convoys may not require too great a party; which would fatigue the troops too much; all wood and defiles between the magazines and the army are to be carefully avoided: and if the army is obliged to move farther off, either retreat before a ſuperior enemy, or to purſue; the magazines muſt move alſo, or new are to be formed. Whoever attentively conſiders the importance of theſe precepts, will agree, that this is one of the moſt eſſential parts of generalſhip, in carrying on a ſucceſsful campaign: many examples might be given that have occurred in this preſent war, where theſe precepts were not apparently ſo well regarded as they ſhould have been, both by us and our enemies: but as our deſign is to inform the reader of what ſhould, not what has been done, we ſhall proceed no farther.

CHAPTER THE FIFTH.

I. *Intrenched camps; their uſe.* II. *Their poſition.* III. *Encampment of troops.* IV. *Intrenched camp of* Ruſſenheim; *firſt ſcheme.* V. *Second ſcheme, with reflections.* VI. *Enquiry into the interior of the firſt.* VII. *Third ſcheme.* VIII. *Defects of the firſt and third.* IX. *Intrenched camp of* Spire.

I. WHEN there are reaſons for keeping a large body of troops together, their camp is intrenched for greater ſecurity.

The *Greeks*, *Romans*, and moſt other nations, ſeldom made any ſtay in a place, without fortifying themſelves in it. The army being aſſembled, forms by its poſition a ſquare, or ſome other rectangular figure of

ſmall circumference, in regard to the number; this cuſtom ſeems to have been practiſed, till the laſt century; but that of encamping in 1 or 2 lines being ſince introduced, cannot be intrenched otherwiſe than by lines; but it is neither of theſe lines, or of theſe tranſitory camps, that we ſhall treat of here.

Theſe camps are of a more modern invention; I do not know, if we are not obliged to *Vauban* for them. They were formed in his time at *Namur*, *Ath*, *Lauterbourg*, and *Dunkirk*; and this judicious general, ventures to ſay in one of his beſt works (*a*) that he wiſhed they were made beforehand at all the frontier places.

The principal objects he propoſes by this, is to put it out of the enemy's power to beſiege the place, or at leaſt to expoſe them to the danger of not ſucceeding.

Were the uſe of theſe camps confined to that alone, it is only in a treatiſe of defence of places, where it ſhould be mentioned, and there could be but little more added on that ſubject, than what that celebrated engineer has given us; however eſſential they may be in that caſe, they are not leſs uſeful in others, which fall under that kind of war here mentioned.

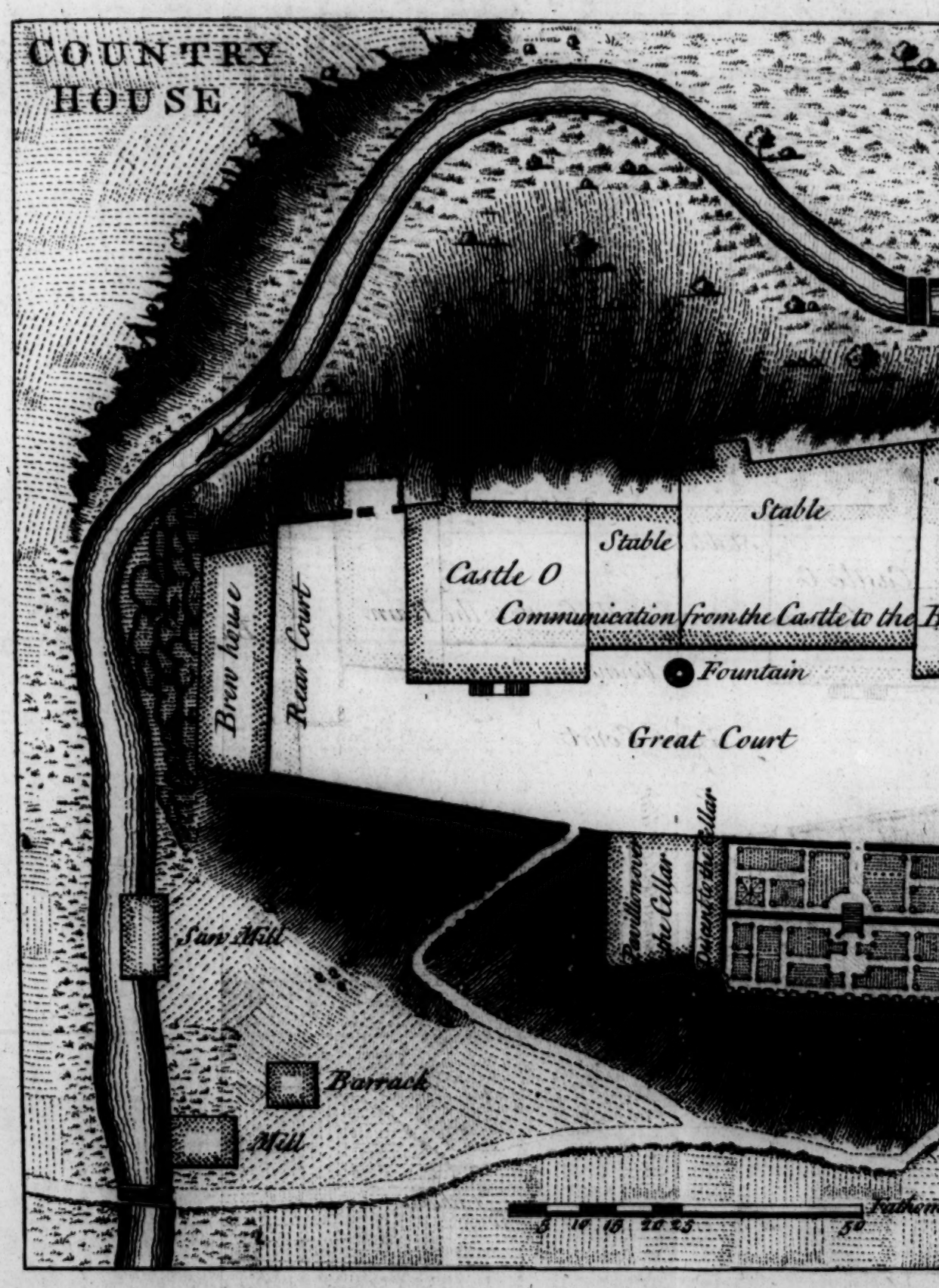
Lauterbourg, for example, with regard to its fortification, and to its poſition with the lines of the *Loutre*, ſhould rather be conſidered as a poſt, than an ordinary place, and with the aſſiſtance of intrenchments, it becomes in ſome manner unattackable.

A town like *Spire*, ſurrounded with a bad wall, without a rampart, is in itſelf incapable of ſupporting a ſiege; but intrenchments being added, are ſufficient to deter an enemy from attacking it.

The advantages of theſe camps extend yet further: an army never expoſes its flanks to a conſiderable body of troops without danger, when this body by its extent cannot eaſily be kept in awe; even ſimple detachments do not make excurſions with impunity, when their paſſage and retreat is made ſo dangerous.

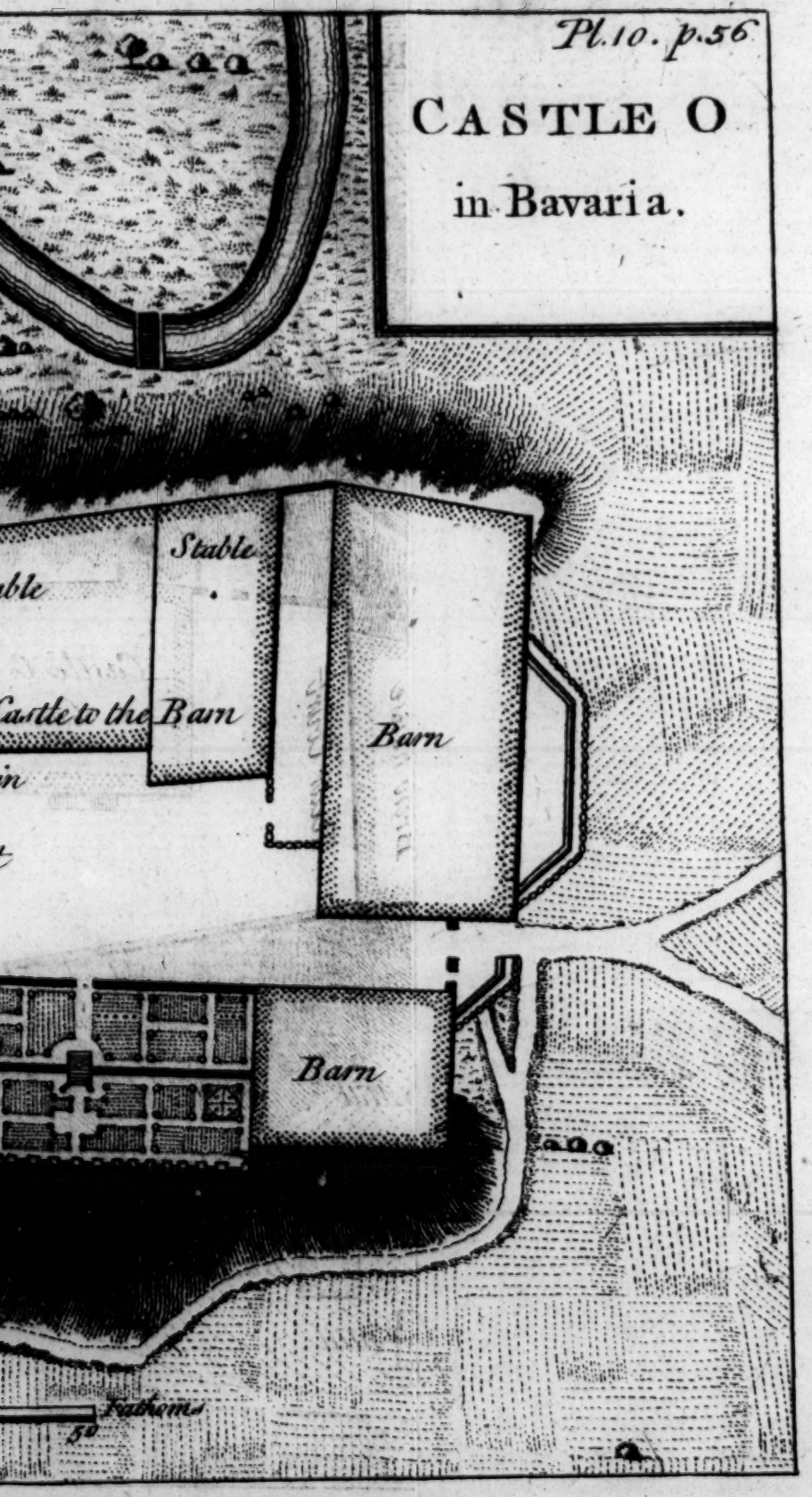
(*a*) *Traite de la* Defence *des places.*

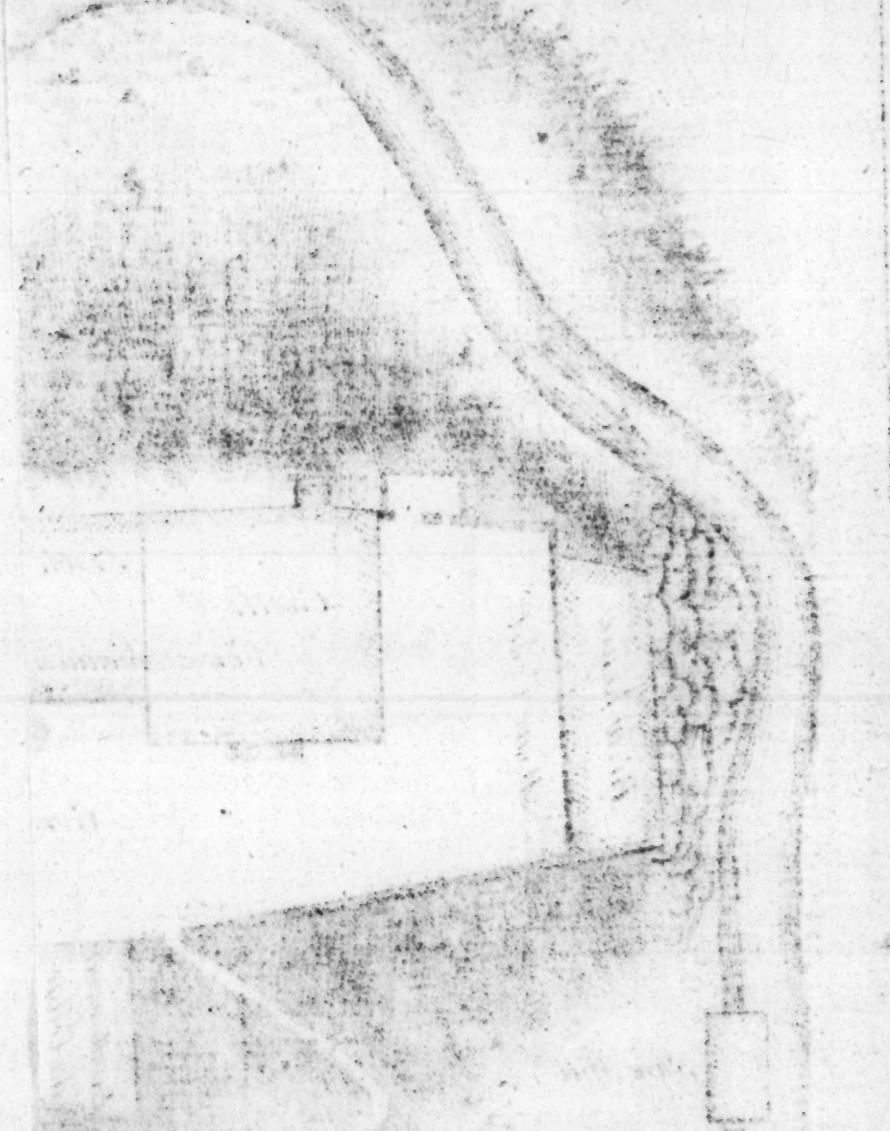
Lauter-


COUNTRY HOUSE
Stable
Stable
Castle O
Communication from the Castle to the
Brew house
Rear Court
Fountain
Great Court
Saw Mill
Barrack
Mill
5 10 15 20 25 50

Pl. 10. p. 56

CASTLE O
in Bavaria.





Lauterbourg and *Spire* can by this means, if neceſſary, cover the country on this ſide the rivers which run through them.

Laſtly, *Vauban* obſerves, that intrenched camps ſerve alſo to place magazines, all kinds of ſtores and baggage, and ſecure the adjacent country, with their families, effects, and cattle.

II. No intrenched camp has hitherto been made but under ſome place, good or bad; which ſerves it for a retreat, or ſupport, as neceſſity requires, and likewiſe has all neceſſary ſuccours at hand; a very eſſential circumſtance.

It is ſeldom that the ground adjacent to a place does not furniſh ſome favourable ſituation: the ancient intrenched camp of *Dunkirk*, ſituated in a plain, was covered on one ſide by the canal of *Bourbourg*, on the other by the canal of *Moure*, and the front defended by *Fort Louis*. That of *Lauterbourg*, inacceſſible in the rear, was on the ſide of a riſing ground, at the foot of which the *Loutre* dividing into 2 branches, runs thro' a flat and marſhy meadow.

Such convenient places are not found every where, it is the engineer's buſineſs to ſeek for them, and ſeize on all advantages. It muſt be obſerved, that theſe intrenchments being much leſs extended, and conſtructed more at leiſure than lines, they are made much ſtronger; are turfed, palliſaded, and more time and care ſpent in fortifying them; by this means there is ſcarce any ground but what may be put into a good ſtate of defence: thoſe that are ſo commanded, that a motion cannot be made without being perceived, and where the parapets on that account do not afford ſufficient cover, muſt generally be excepted. Low, marſhy, unhealthful places, and where there may be a ſcarcity of water, ſhould equally be rejected.

III. When the ground permits, the figure of the camp ſhould neither be triangular nor long, but ſuch, that its ſuperficies may be the largeſt poſſible, in proportion

portion to its circumference. Of all rectangular figures, the ſquare contains more ground in proportion to its boundary than any other, and thoſe which come neareſt to it contain more than others.

The circumference is regulated by the number of troops deſtined to occupy the poſt, or when it cannot be avoided, the number is regulated by what the place can contain.

In either caſe, it is neceſſary to know what ſpace muſt be allowed for the encampment and motions, this cannot be known without entering into ſome detail; as well becauſe of the difference of the number of men in the companies and troops that compoſe the battalions and ſquadrons, as the variations common in this caſe.

The front of the camp muſt be parallel to the intrenchment, and if poſſible 50 fathoms diſtant from it at leaſt, that the troops may be drawn up in order of battle, and perform their neceſſary evolutions.

A foot ſoldier's tent is 6 feet ſquare, excluſive of the boot: 7, or 5 ſoldiers and 1 ſerjeant, are allowed to a tent: the firſt and laſt face the front and rear of the camp, the reſt are parallel to the front.

A company ſtrong or weak always encamps in file, and conſequently has but 1 tent in front. The files or companies are backed 2 by 2, leaving an interval of a little ſtreet for the boots.

M. Bombelle gives 6 paces or 3 fathoms in front for the 2 files of tents. *M. Haricourt* allows only 5 paces, which is as little as poſſible, the little ſtreet for the boots being thus only 3 feet.

Between every 2 companies there is a great ſtreet of 16 paces, according to 1 of theſe officers, and only 6 according to the other; a like ſtreet ſeparates the grenadiers from the battalion, whoſe tents are not backed by any others.

The front of a battalion is thus equal to 90 paces, or 45 fathoms; becauſe the battalions conſiſt of 9 compa-

companies, inſtead of 17, when *M. Bombelle* wrote; which ſhews, that in encamping regard muſt be had to the ground that the troops take up when drawn up in order of battle.

As to the depth, *Bombelle* allows 32 paces for 11 tents, and *Haricourt* 17 for 6, which is much the ſame, ſince there is always 1 pace between each, without regarding the boot of the firſt and laſt.

From the laſt tent of the ſoldiers the reſt are placed as follows; to the kitchens is allowed 10 paces; to the drummers and ſuttlers 20; to the ſubalterns 35; to the captains 45; and to the field officers 80.

A *French* battalion on its preſent eſtabliſhment takes up for its camp 45 fathoms in front, and 48 3 feet in depth, reckoning from the head of the tents; it is clear that nothing can be deducted from the firſt of theſe dimenſions; but in the caſe we are ſpeaking of, the 3 field officers are commonly in lodgings, and the other diſtances may be diminiſhed; I do not ſee the leaſt inconveniency to reduce the depth to 30 fathoms.

The interval of 1 battalion from another is commonly 10 fathoms, there cannot well be leſs. The 2d line is generally 100 or 200 fathoms from the firſt, unleſs in certain caſes, ſuch as an intrenched camp, where 40 or 50 fathoms are ſufficient.

Cavalry are commonly placed in the 2d line; each troop, as the infantry, has but 1 file of tents, and like them, 2 troops are backed to each other. Seven paces are allowed for 2 of theſe backed files, including the little ſtreet; 3 paces from the front of the tents to the piquets for the horſes, which face the tents, and 12 or 15 paces from 1 range of piquets to another, ſo that the horſe may have a ſtreet ſufficiently wide between.

The camp of a ſquadron of 4 troops takes up 50 or 56 paces in front, and its depth determined according to the number of men, allowing 7 men to a tent, and 7 paces from the pole of 1 tent to the next, including the

the quarter maſters; that every horſe may have 3 feet in breadth.

At 15 paces from the piquets are the kitchens and forges; at 25 the ſuttlers; at 45 the ſubalterns; at 65 the captains, and 30 paces farther the field officers.

There is no interval between the ſquadrons of the ſame regiment. *M. Haricourt* allows 10 paces from 1 regiment to the next, 30 between the brigades, and 40 between the cavalry and infantry.

I do not mention the bells of arms, nor ſtandards, tho' it is from thence we commonly reckon the front of the line; nor the quarter guards and neceſſary houſes, this detail not being eſſential here. It is right to conſult all theſe things with the quarter-maſter-general, or take the orders directly from the general.

IV. I ſaid we never had an intrenched camp but near ſome town or fortreſs; I ſhould have excepted the following.

11th of *May* 1734, I was ſent from the army at *Bruchſal*, to *Ruſſenheim*, a village 1 league above *Philipſbourg*. I there found the brigades of *Gondrin* and *Britany*, each of 4 battalions, and the regiment of dragoons of *Languedoc*, under the command of *M. de Balincour*. This place, being intended to be made a poſt, could not contain ſo many troops; it was therefore neceſſary to fortify the camp, which was extremely eaſy, the ſituation being very favourable.

Plate XIII. The plan ſufficiently ſhews this: the ground to be occupied was higher on the flanks and rear than its environs. The right was covered by a quick hedge and bounded, as well as the village by the *Pfintz*, a little river with ſteep banks, where another arm and 2 rivulets fall into it. I obſerved grooves, and a free-ſtone flooring at the bridge, which made it eaſy to form an inundation. Some banks could therefore eaſily confine the water, and raiſe it 8 or 10 feet from the foot of the village, to the place they fall into the river: the meadows near the river were low and marſhy.

marſhy. On the left a meadow commanded by a riſing ground ſeparated it from the *Rhine*, and the chapel being on a ſteep, higher ground than the reſt, and covered with briars and buſhes, ſerved as a citadel.

Having by this only the front to intrench, and no want of workmen, I was determined to ſpare no pains. In the evening I ſtopped the water to make the inundation; and after making my report to *M. de Balincour*, whoſe ſentiments agreeing with mine, he ordered me to trace out the new camp the next day, in every reſpect, as in my ſketch.

The fortification is very ſimple and plain; it is a kind of horn work of 150 fathoms front, covered by a ravelin; the perpendicular 20 fathoms, and the faces 40: the right branch runs parallel to a hedge, which covers it; but the left, being of much greater extent, is flanked by returns at right angles, and by the chapel.

This line need not be very thick, as the returns only are expoſed to cannon, becauſe there is no probability that the enemy will engage in this confined place, where they are flanked beſides by a conſiderable fire.

An engineer always works with pleaſure when aſſiſted by nature, but I was ſoon deprived of this ſatisfaction. I had ſcarce marked out the camp, when *M. Portal*, who commanded us, arrived. He in general approved of my ſcheme; would only have the head of the bridge ſecured by 2 redouts, and to make 3 redans, inſtead of the 2 half baſtions and to the ravelin; perhaps he had at that time deſigned the baſtioned lines, which we ſoon after traced before *Philipſbourg*; however he charged another engineer with the work, and took me the next day to viſit the lines on the *Loutre*, where I was in chief.

V. I know not how this poſt was fortified, as I did not ſee it afterwards; but being confined to the figure, it was very difficult in other reſpects to conform to what was ordered.

I ſhall

I ſhall find in the enſuing chapter, that redans have ſome eſſential defects, by the obliquity of their defences. Theſe defects, though known, do not prevent from uſing them to cover right lines and rentring angles; as to ſaliants, when they are right or acute, as the inconveniency increaſes in proportion to their acuteneſs, I know not that the means of uſing them there has been found.

We commonly uſe ſmall baſtions, and in the caſe we are ſpeaking of, it being impoſſible to make demi-redans, we ſubſtitute demi-baſtions.

From the point of 1 redan to the next is 120 fathoms, and the front was only 150. It was therefore neceſſary, in conformity to cuſtom, to return nearly to my ſcheme.

A redan may be placed inſtead of the ravelin, tracing the ditch parallel to the faces, to diminiſh the length of the faces of the half-baſtions, which, on account of the great extent of the front, I had left larger, to draw the fires nearer, and to change the direction of the flanks; but with all theſe alterations they are nevertheleſs demi-baſtions.

I here ſuppoſe that 10 fathoms, reduced to 8 or 9 by the thickneſs of the parapet, are inſufficient to flank a redan; the principal difficulty conſiſts only in the ſmall extent of the front. We could not extend it to the *Rhine*, in a right line, without being commanded in the meadow from the height, but it may be prolonged to the ſide of the height, which removes all obſtacles. The draught annexed ſhews this prolongation.

The manner is very ſimple, and perhaps new, to do without baſtions on the angles, be they ever ſo acute.

If redans are ſufficient to flank common intrenchments, I doubt whether they are ſo good to be uſed in an intrenched camp, which is made to be defended with very unequal forces, and having in proportion leſs extent, ſhould, when poſſible, be fortified with more care.

VI. I hope it will not be thought I would commend my firſt ſcheme; though I think it better than the 2d, yet it is far from being perfect.

I here remark the defects of forts; the 1, which is the ſubject of this article, depends on the placing of the line; the other, more eſſential, which regards the method of fortifying it, and ſhall be treated of in ſome of the ſubſequent articles, and in chap. VIII.

I make it an eſtabliſhed rule, that the head of the camp ſhould, if poſſible, be at leaſt 50 fathoms from the interior part of the intrenchment, whereas in the plan it is but 25. The camp of the dragoons, reduced to 69 fathoms in front for 3 ſquadrons, is a little crowded, and is alſo on the right againſt the branch it muſt defend, and its rear towards the village.

Laſtly, there being only 120 fathoms from the angle of the left demi-baſtion to the *Rhine*, it may be aſked, why the front is not continued to the *Rhine*, ſince that line, about 2 thirds ſhorter than that which runs towards the chapel, would incloſe more ground.

To this I anſwer; my deſign was to have brought the fortification more forward, by which means the troops there, and in particular the dragoons, would have had more room, but I was not maſter: it was thought neceſſary to have as little parapet to line as poſſible, and that it could not be done, but by contracting the camp.

I doubt whether theſe defects are here of any great conſequence, I know that a common intrenched camp, or a line, ſhould be defended by a large body of troops, drawn up in order of battle; and as it is a uſeful and durable work, ſhould have room for all ſorts of ſtores: I conteſt none of theſe reaſons; but with a little reflection, it will be found, that this was not exactly the caſe here. For this poſt was properly but an intrenched village, which could not ſerve to keep ſtores, and there was no reaſon for keeping it long, and in effect, was abandoned long before the end of the ſiege of *Philipſbourg*.

As

As to the left branch, I might add, that I preſerved by that the ſuperiority of the ground; that, had the front been extended to the *Rhine*, I ſhould have run the riſque of being plunged from the riſing ground, and this part of the intrenchment, though much ſhorter, required much more work than the other; beſides the addition of a ravelin, it muſt have been conſtructed much ſtronger, to be able to reſiſt cannon. But I declare, that having only reconnoitred the ground in general, that ſcheme, ſimple and natural as it may appear, did not ſtrike me in the leaſt.

VII. Theſe replies, in general, appear rather excuſes than reaſons; which have occaſioned a 3d plan; whoſe front is a crown-work, traced after the uſual method, except the flanks, which are perpendicular to the lines of defence. It does not reach beyond the high ground, to avoid being plunged, but the return of part of its branch ſupplies that with little expence, and without inconveniency, as it is flanked and covered by the reſt. Plate XV.

The front of the camp, as in the others, is only 25 fathoms from the intrenchment, becauſe I believe it is ſufficient here; the cavalry placed as uſual in the 2d line, are 50 fathoms from the infantry, at the neareſt place, and have more room on their flanks and rear.

This new deſign, reckoning the increaſe of the ravelin, has no more extent than the firſt; it is then preferable, as it incloſes more ground. 10 battalions and 6 ſquadrons have here more room, than troops by a 4th leſs, have in the other.

As ſo conſiderable a body of troops are capable of undertaking ſome extraordinary enterprizes, and it is always material to ſhorten the time they loſe in filing off as much as poſſible, I have placed a gate in each curtain, and 1 on the left near the branch, which being leſs ſeen by the enemy, may alſo be deemed an advantage.

VIII.

VIII. This plan ſhews how the inconveniencies of the former may be avoided, is exempt from them, yet all are defective in ſeveral material points.

We cannot attend too much to the flanks, in them conſiſts the principal defence: theſe are very large and well directed, but what advantage is reaped from them? As there is only 5 or 6 fathoms between the faces and the counterſcarp for them to play upon, the reſt of courſe fires on the ravelin.

This ravelin, neceſſary to cover the barrier, is more hurtful than uſeful: it defends the acceſs to the faces I allow, and if we ſuppoſe a regular attac, it may be of ſervice; but as we are here more expoſed to a ſtorm than a ſiege, and, as in this caſe, it is very dangerous to ſtand your ground in a detached work, the beſt way will be to retire with your troops, the moment of the aſſault, to avoid confounding your own troops with the enemy, or ſeeing them ruſh in thro' the barrier.

The flanks having thus their full liberty, the beſiegers will be expoſed to a dreadful fire, while in the ravelin: but then thoſe oppoſite the faces will be the leſs.

Theſe baſtioned fronts have this inconvenience, the ditch is ſo large (in proportion to the reſt) between the ravelin and the curtain, that the excavation becomes tedious, and wheel-barrows, or hand-barrows muſt be employed to tranſport the earth to the proper places. To remedy that difficulty, I practiſed the following ſcheme, in a ſimilar caſe.

IX. In *April* 1735, Lt. Gl. *Quadt*, ordered me to make a ſcheme for fortifying *Spire*, where he commanded, together with a retrenched camp. I ſhall treat of this laſt only; the ſituation was very favourable, no better could be deſired than that between the *Spire* back, and the new back.

This poſition, in regard to the place, was as convenient in large, as that of *Ruſſenheim* in ſmall: I made the front about 500 fathoms, it commanded, and was

more extenſive, than the ground by which it can be approached.

It was neceſſary to occupy the tower of *Spire*, by way of an advanced guard or poſt, by which the enemy's motion can be diſcovered as far as the wood: but to be abandoned in caſe of a general attac.

A ditch of 30 feet wide, and 9 or 10 deep, runs cloſe to this tower; this is a great obſtacle, eſpecially for the horſe to paſs under the fire of cannon. The camp could not be made nearer to the town, without loſing in every reſpect the advantage of the ground.

The right branch deſigned to make part of the lines, traced on the ſide of the river, which I had before received orders to reconnoitre, was to have been covered by an inundation. 2 heights run along-ſide of it; I followed the loweſt, not to crowd the figure, and to be nearer the water-ſide, it is higher than all before it by ſome feet.

The left extends along the *Neuback*, which in that place was 15 feet deep, and 9 fathoms broad, it can overflow the meadow, adjoining this branch, 4 or 5 feet high.

The *Palatines* tower is ſo near, that I thought it ſhould be joined to the line, as it commands an extenſive proſpect, its communication flanks all within reach, and covers 1 of the dams neceſſary for the inundation.

Laſtly, ſo favourable a ſituation, as to the plan, would be perfect in all reſpects, if theſe advantages were not in ſome degree counterbalanced by an eſſential defect; but as my deſign is to quote examples, and not give the hiſtory of places, a longer detail would be as foreign to my ſubject, as the explanation of the motives we then had in view.

I could not ſuppoſe an attac in front only as at *Ruſſenheim*, and I had reſolved to make it with baſtions, but being at leiſure to trace my ſcheme on paper, I diſcovered the inconveniency of removing ſo much earth;

and

and by making the ditch parallel to the faces; there were parts that could not be ſeen or defended.

This circumſtance did not diſcourage me; I therefore ſloped this troubleſome part of the counterſcarp in form of a *Glacis*, and that the fire of the flanks might have greater effect, I placed the paſſages of the gate at the extremity of the faces of the ravelins. The plan will explain the reſt: I thus corrected my baſtioned fronts in ſome meaſure, but am ſenſible that I only remedied 1 part of their defects. Shall treat more ſatisfactorily on this method in chapters 7 and 11.

Observations on the fifth Chapter.

The author obſerves, that the ancients formed their camps into ſquares, or nearly ſuch; but as the preſent manner is to contrive them ſo as the troops may be placed in 2 lines, the ſquare form cannot be obſerved. It is a maxim of the moderns, to encamp the troops in the ſame order as they are to fight in, that is, in 2 lines; the foot in the middle, the horſe at the wings, and the body of reſerve behind. As the preſent manner of drawing up an army in order of battle may be, and has been conteſted by men of extenſive knowledge and ability; the ground will not always permit to form ſo great a front; nor will there be always found a proper ſituation to incamp in this manner. M. *Saxe*'s method of drawing up an army is a ſufficient proof, that the modern cuſtom is not ſo advantagious as imagined. It is therefore the ſituation of the ground that ſhould determine the manner in which an army ſhould be drawn up, or to incamp; when the ground is convenient, they ſhould form a ſquare camp; as it requires the leaſt work to intrench it, as we have ſhewn in a former obſervation. In doing this I can ſee no inconvenience to form any line of battle: for I ſuppoſe, that ſo ſoon as a camp is formed, the ground for drawing up the army is pitched upon before the camp, and the order of the troops to march out determined: and ſhould

the enemy attempt to force the camp, no better form can be pitched on to defend it than the ſquare.

To form a retrenched camp near a town or village, is advantagious in many reſpects; it furniſhes room to place magazines for ſtores, forage, baggage, and for the ſick and wounded; the houſes and buildings cover the flanks of the camp, which therefore may be made more compact than could be done otherwiſe. Such a camp covers alſo towns, when fortifications are inſufficient to reſiſt an army. For inſtance, that at *Dunkirk*, which covers that town on the land ſide; its ſituation being ſurrounded by canals and inundations, that 15 or 20,000 men in it, could not be taken by the moſt numerous army.

When a camp is ſo ſituated, as cannot well be approached but in front, the author ſeems doubtful, whether that front ſhould be fortified by a line with redans or with baſtions; the firſt manner has leſs defence, and requires leſs work; on the contrary, the baſtions are able to make a better defence, as may be ſeen Plate 15; it requires much time, and a great deal of labour to remove the earth out of that part of the ditch before the curtains; and though the flanks are large and well diſpoſed, yet as the ditch before the faces is but narrow, and the ravelin ſo cloſe, they can make but a very ſmall defence. I am ſurprized that an author, of ſo much experience as *Clairac*, ſhould commit ſo many miſtakes, before he could find out the manner of correcting this inconveniency. He was ſenſible, that a front with baſtions was preferable to 1 with redans, in all other reſpects except the want of room for the fire from the flanks to extend as far as it ſhould. There was no occaſion for ſo many examples as he has given to ſee; that by removing the ravelins a little farther from the curtain, and to ſlope the ditches of the faces near the ſhoulders, it would remove that defect.

The author ſays, that the ſpace each regiment takes up in a camp muſt be known before the retrenchment

can

can be made; but as the particulars he gives relate to the *French* army, which are different in ours, we ſhall give here ſuch as are neceſſary to be known upon ſuch occaſions.

The depth of a regiment of infantry incamped, of 9 companies, each of 100 men, computed from the ſerjeants tents to the rear, is 200 yards, and the front 245, including the battalion guns. If the regiment conſiſts of 9 companies, 70 men each, the depth is alſo 200 yards as before, but the front only 150, including the battalion guns.

The front of a regiment of dragoons incamped, conſiſting of 6 troops, forming 3 ſquadrons, with the light troops, takes up 200 yards, and the depth 258: the interval between 2 regiments of foot or dragoons is 60 yards. The particulars of the foot and horſe camps are foreign to our purpoſe; thoſe who are deſirous to know more of this matter, may conſult the military diſcipline, publiſhed by *J. Millan*, where they will find plans, &c. of the preſent incampments for horſe and foot.

CHAPTER THE SIXTH.

I. *Different uſes of lines.* II. *Objections and anſwers to thoſe that cover an army.* III. *Thoſe that cover a country.* IV. *Thoſe deſigned for a new ſyſtem of a defenſive war.* V. *Neceſſity of ſupporting the extremities of theſe lines, and how.* VI. *Diſtance of lines, from heads of camps.* VII. *Defects of common lines.* VIII. *Means of correcting them.*

I. THE uſe of lines may be divided into different claſſes; the 1 neceſſary to hinder ſuccours, or curb the enterpriſes of a large and active garriſon during a ſiege, concerns the attac of places only, and conſequently foreign to our ſubject.

The other, mentioned by few authors, regards the rendering an army formidable in a retrenched camp; to prevent the enemy's excurſions, by oppoſing an impenetrable barrier; or laſtly, to ſecure an army, ſo as to keep upon the defenſive with ſafety, if judged neceſſary. Though an engineer is ſeldom acquainted with the general's deſigns, even in this caſe; yet, as he ſhould not form any ſcheme without being able to anſwer any objections that may be made againſt his works; we ſhall here examine the different opinions, commonly alledged for and againſt theſe different kinds of retrenchments.

II. To ſupply by art the defect of a bad ſituation, neceſſarily to be occupied, ſtands to reaſon; wherefore to fortify the camp of an army cannot reaſonably be blamed, provided the works are not too extenſive, well directed, and ſo diſpoſed, that the army may conveniently make any motion upon occaſion.

Theſe conditions which include the whole, leave no room for any objections, but their execution is not always eaſy. Suppoſe there are reaſons that an army ſhould keep upon the defenſive, and avoid an engagement; it is neceſſary to find either an inacceſſible camp, or a poſt which can be attacked no where elſe but in a front well fortified in every part. I know of no other alternative; yet this may not prevent our applying the following words of M. *Feuquieres*, which in fact are as applicable here as to lines of the 3d kind. *An intrenched army*, ſays he, *cannot ſally out but by a ſmall front; and conſequently the enemy in his approach, being free in all his motions, may make them as hazardous as he pleaſes, without fearing the leaſt inconveniency: I conclude, that an army which is ſtraitened in all its motions is always inferior to another, though equal in number, which can move with an entire liberty, and may run any riſk with impunity.*

This maxim is worthy of its author; I have already declared that the application may be juſt; but being unable to hurt an enemy, is only an inconvenience to

which

which we may oppoſe the grand motive *neceſſity*, which according to our ſuppoſition obliges us to attempt every thing to avoid an engagement. M. *Feuquieres* is ſo far from blaming this practice, that he ſays, there are examples of batteries being raiſed, and even trenches opened in form, to force an enemy from their intrenchments, thrown up for want of a good ſituation; an enterpriſe which, in his own words, "always ſuppoſes a "great ſuperiority in the aſſailants, and even a neceſſity "of coming to action, which is ever attended with a "great loſs of men."

Were there no reaſons for avoiding an action, but only to balance the ſuperiority of numbers by fortification, then ſome detached works, whoſe quantity and ſtrength, determined by this inequality and ſituation, may be ſufficient, whence the preceding objection has no weight: but are there no others? "Nothing ener-"vates the courage ſo much," ſays the ingenious * author in the preface to a new ſyſtem of fortification, "As to think one's ſelf on the defenſive; becauſe it is "very natural to reaſon thus; I defend myſelf, con-"ſequently then I am in danger, or rather I am the "weakeſt; but an idea of danger, and a knowledge "of weakneſs, diſmays the braveſt."

This is true, in general, and we ſee the conſequence that may reſult from it, even in the caſe we are now treating of; but it is always in a general's power not to be on the defenſive? And ſo far is fortification from being a diſcouraging teſtimony of our weakneſs, that we may regard it as a remedy to ſupply its defects? "The ſhovel and the pick-axe, ſays *Folard*, treating "of this kind of war, are the recourſe of the weakeſt, "or of thoſe that would not hazard an action; they "are the only arms by which they defend themſelves, "and the beſt to hinder the effects of others."

* *Le Pere Caſtel, Jeſuite.*

III. Lines, of the 2d kind, fall under the ſame objections, and are even more expoſed to cenſure. Their principal deſign is to defend the country they cover from contributions; to have it in their power to raiſe them; to preſerve a communication from one place to another, without the neceſſity of eſcorts; and render theſe places not liable to be attacked, as long as they ſubſiſt.

Feuquieres pretends, that all theſe advantages, except the laſt, are not real; or counterbalanced by great inconveniencies; he thus explains himſelf.

"Experience, ſays he, has frequently convinced us, "that theſe lines do not hinder a country from paying "contributions, ſince to eſtabliſh it there needs only "an opportunity of forcing them once, during the "whole courſe of a war; after which, tho' the troops "that forced the lines ſhould be obliged ſuddenly to "retire, the contribution has been demanded; and in "a treaty of peace, if made with any equality, they "muſt be accountable for the ſum impoſed, tho' not "raiſed; thus lines are of no uſe in guarding a country from contribution.

"The 2d reaſon, viz. that of eſtabliſhing contributions in an enemy's country does not hold good. It "is not the parties that ſally from lines, but thoſe from "fortified places, that levy them.

"That of facilitating a communication from one "place to another, continues he, is more apparent, for "thoſe who would go without eſcort under cover of "theſe lines; but if it is for the ſecurity of convoys, "then that facility is only apparent; for if a prince "reckons what the conſtruction and maintenance of "theſe lines coſts him, and the quantity of troops they "require for their defence, I am perſuaded, that he "would find theſe troops more uſefully employed in "guarding places, eſcorting convoys, and with the army, than in guarding theſe lines."

I have

I have already obſerved, that this author ſays nothing againſt that eſſential advantage, of preventing places ſurrounded by theſe intrenchments from being inveſted.

Such an authority is certainly reſpectable; but theſe maxims ſeem to be advanced in a very general manner. There are lucky ſituations, among others, are thoſe from *Bergues* to *Dunkirk*, and from the mountain to *Lauterbourg*, which being carefully fortified, would prevent their being forced or penetrated by a ſmall body of men ever ſo bold; therefore ſuch lines would prevent contributions being raiſed.

They have alſo the means of impoſing contributions; for it is not clear, why a party ſallying from thence have not the ſame privilege in that reſpect as others.

Laſtly, if, as in the firſt caſe, ſuch lines join to fortified places, theſe places become unattackable; and if, as in the other, they join to an encloſed town, but little fortified, it cannot well be ſupported, but by ſuch aſſiſtance. I agree that this cannot be on the *Loutre* without a certain number of troops; but are they entirely loſt there? No, ſince they cover all lower *Alſace*, they keep in awe, and even diſtreſs a body of troops, at leaſt equal to them, unleſs the enemy abandons all the country before them.

The lines from *Bergues* to *Dunkirk* have this further advantage, that even in the preſence of an enemy, the garriſons of theſe places, and the adjacent poſts, may be ſufficient to guard, or at leaſt defend them.

Every one muſt agree, that it is much better to do without an eſcort, than be obliged to take one, were it for no other reaſon but that they may be beat?

To theſe objections, M. *Feuquieres* had added that of the expence, which he ſays, exceeds what the contribution will come to: this can but very ſeldom be true; beſides other advantages which may be drawn from them, we muſt add, that of depriving the enemy of that contribution, which they otherwiſe could make, either in money, ſubſiſtence, or labour.

IV. The

IV. The kind of lines, M. *Feuquieres* moſt briſkly attacks are thoſe, which according to him, have of late years eſtabliſhed a new ſyſtem of defenſive war. "Experience, ſays he, has ſhewn the falſity of this ſyſtem, which conſiſts in two inconteſtible points."

The firſt is that we mentioned of armies encloſed and confined in intrenchments. "An army (adds he) "in lines, is never compact, becauſe it muſt defend a "great front, and conſequently when ſurprized in one "part, either thro' the nature of the country, or the "night, which may conceal the enemy's march, it is "certain this attac can only be ſupported by one part "of the army; for the reſt cannot march to their aſ-"ſiſtance where the real attac is, but with great diffi-"culty and in column, which is dangerous."

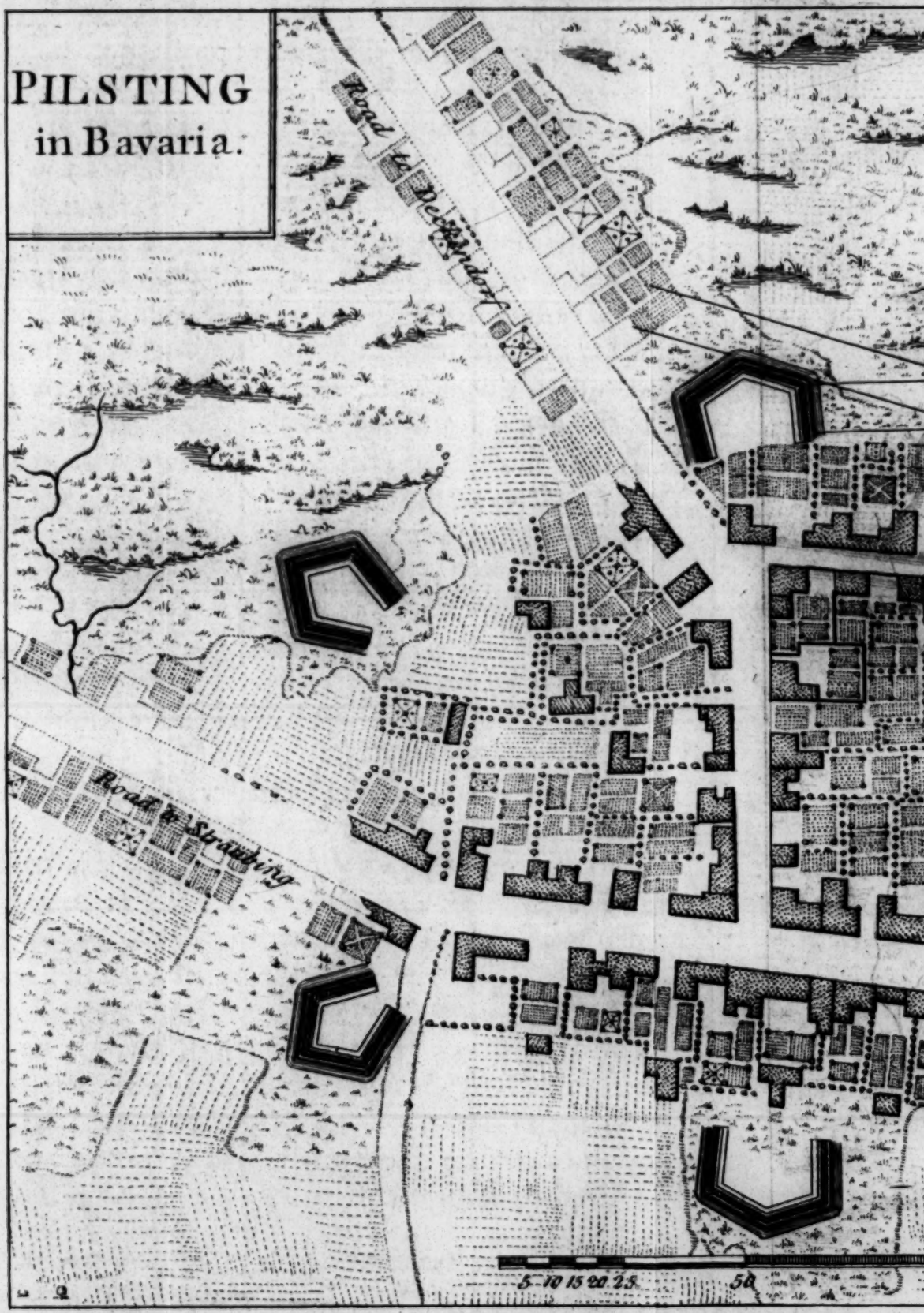
He afterwards remarks, that theſe lines being greatly extended, and conſtructed with the view already mentioned, muſt greatly weaken an army to guard them; in conſequence of which they have been forced every time they have been attacked; and beſides, their exceſſive extent preventing their being ſufficiently furniſhed with redans and other works, they cannot be good; that is, they cannot be fortified with ſufficient care.

I ſhall not pretend to anſwer theſe objections, ſo ſolid in themſelves, while they only regard ordinary caſes; I agree, that as to their extent, ſimple intrenchments of 4 or 5 leagues are not ſufficiently fortified to ſecure an army tho' equal in number from being expoſed; but ſuppoſing a favourable ſituation, theſe lines do not much differ from the 2d kind; we may therefore alledge in their favour, what we have ſaid of the others.

The lines of the *Loutre* (*a*) for example, are more than 5 leagues long; yet if they were in the ſtate they

(*a*) Theſe lines are the ſame as thoſe of *Viſſembourg*, which *Feuquieres* mentions in his remarks; I do not know that they have been either forced, or abandoned ſince 1706, when taking the advantage of the ground they were covered by inundations.

might


PILSTING
in Bavaria.
Road to Deggendorf
Road to Straubing
5 10 15 20 25 50


Road to Landau
Fathoms
100

might be put in, with leſs than 2 months work, 20,000 men could defend them with ſucceſs, againſt the moſt numerous army.

It is true, they have one of theſe conditions which *Feuquieres* afterwards demands, *viz.* to reduce the enemy to certain places of attac, and it will be difficult, even to find but one that is practicable; and tho' they are long, yet they ſupport as well the only bad place found in them, as they are alſo ſupported by it.

We may then conclude, that as there is not any kind of lines, to which we cannot make ſolid objections, ſo there are none from which we cannot draw great advantages, when art is ſeconded by nature; I ſay ſeconded by nature, for if they can be flanked and enfiladed, it is evident they are of no advantage. I am convinced, and ſhall always think, that lines raiſed in dry, even and open ground, ſuch as a vaſt plain, are more dangerous than uſeful, when their extent is more than the front of an army would occupy in battle. As to intrenched camps, we know that *Feuquieres* did not find the attac ſo eaſy, which is equal to an approbation; *Folard* and *Santa Cruz* mention them, the firſt as a *practice of the ancients, which we have left off, for another much leſs advantagious*, namely, that of grand guards, poſts and detachments in front; the other as the beſt means of eaſing the troops; to be capable of making great detachments; not to engage but when it is thought to advantage, and not *when the enemy pleaſes.*

V. The chief attention in planning lines, is, as before obſerved, to ſupport the extremities, ſo that they neither can be flanked, nor the enemy attempt it.

This precaution is more or leſs neceſſary, according to the uſe theſe lines are deſigned for: if they muſt cover a whole country, as thoſe of the *Loutre*, a vaſt and thick foreſt, which is yet better for being marſhy; a chain of mountains with narrow paſſes, which are eaſy to be defended; a broad and deep river, or any ſuch objects, are of great utility.

Theſe advantages are abſolutely neceſſary in this reſpect, for they are no guard againſt incurſions without them, and ſuch intrenchments, being generally of a great extent, in proportion to the number of troops that guard them, they are almoſt only ſupported by the goodneſs of their fortification; ſo that the enemy might not have time to flank them, before their too weak and much diſperſed defenders have time to collect themſelves to make them repent of ſuch a movement, even if they were ſtrong enough for ſuch an enterprize.

Theſe poſitions, both favourable and indiſpenſible, are ſcarce, I agree, but ſuch lines ſhould be ſeldom uſed: as to thoſe deſigned only to cover an army, which will not come to action but with that advantage, a fortified place, a town encloſed with walls, a country caſtle, a little wood that may be filled with infantry, a moraſs known to be impracticable, a river with deep banks, or muddy, are ſufficient: theſe may yet be ſupplied, as we have ſeen, by covering the flank by an intrenchment with redans, or by felling.

There are even examples that a general, not content with theſe precautions, has intrenched himſelf in the rear, and thus ſhut himſelf up on all ſides, which forms a new kind of intrenched camp, fortified according to the nature of the ground; but theſe examples are not frequent.

VI. If in tracing lines we are obliged, at leaſt in the principal parts, to follow a camp already fixed, which ſometimes happens, or that ſome village muſt be encloſed, which is not ſo rare, it is equally neceſſary for an engineer to know what ſpace ſhould be between the intrenchment and the front of the troops.

At *Philipſbourg*; for lines of circumvallation not differing materially from theſe, but in their circular figure, what is agreeable to one is ſo to others; at *Philipſbourg*, this diſtance was fixed at about 65 fathoms, and more was not left between the intrenchment and the village of *Oberhauſen*, though there were troops encamped between

tween them; it muſt be obſerved, that this diſtance is contracted as much as poſſible, the better to unite the forces.

M. *Vauban*, in his treatiſe on ſieges, has fixed this diſtance at 100, or 120 fathoms; this he afterwards extends from 60 to 120, in his treatiſe on the attac of places: it may be dangerous to give more or leſs; for in the firſt caſe, the troops will be too far from what they are to defend; in the 2d, they will not have ſufficient room to move in, and to leave a paſſage in their rear, for a body of troops to march wherever its aſſiſtance may be wanted, to ſupport a part giving way, or too hard preſſed: we may then determine this diſtance (unleſs in particular caſes) from 80 to 100 fathoms.

As to the parts oppoſite the villages, it is neceſſary, in my opinion, to add the depth of the camp to this diſtance, if the depth does not exceed 60 or 80 fathoms, counting from the bells of arms, or ſtandards, to the ſubalterns tents, or to the kitchens at leaſt, included.

VII. All lines may be fortified in the ſame manner, not excepting thoſe of circumvallation and countervallation, they only differ from the reſt in their uſe.

The common and almoſt univerſal method is to flank them by redans. In open ground for thoſe of circumvallation, M. *de Vauban* allows 120 fathoms, from the point of 1 redan to that of the next; 30 fathoms for the gorge, and 22 for the capital; which makes the faces about 27 fathoms: it was thus we traced thoſe at *Kell* in 1733, and nine years afterwards at *Nider-Alteich* in *Bavaria*. Plate. XVII. Fig. 1.

The flanked angle of theſe little works is 68 degrees 34 minutes, which is open enough; but ſuppoſing the lines of fire to ſquare on the faces, as their angle with the curtain is 34 degrees 17 minutes, they paſs more than 30 fathoms before the middle of the curtain, and do not croſs the capital of the oppoſite redan but at 49 or 50 fathoms from the point.

It muſt be further obſerved, that ſuppoſing, as we generally do, the range of a muſket 120 fathoms, the collateral fires, ſo far from croſſing on the capital, leave more than 7 fathoms between the 2 neareſt.

Thus, reckoning the range of ſhot as before, and ſuppoſing alſo that the ſoldier fires directly before him, each curtain forms the baſe of an *Iſoſceles* triangle from 30 to 31 fathoms perpendicular, which is not flanked, and before each redan there is a ſpace of 30 fathoms broad, communicated to another of the ſame breadth, by a paſſage of 11 or 12 fathoms, which is not raked from any part; this will be better underſtood by the plan annexed: laſtly, the ditches have ſo oblique a defence, that it is evidently of very little effect.

From my freedom of explaining myſelf, I hope it will not be thought I attempt the critic; a title that would as ill become me as I deteſt it: I quote and examine with ſincerity; let the judicious reader decide: my own inſtruction, and that of my brother officers, is, as I have already declared, my only motive in diſcuſſions of this nature.

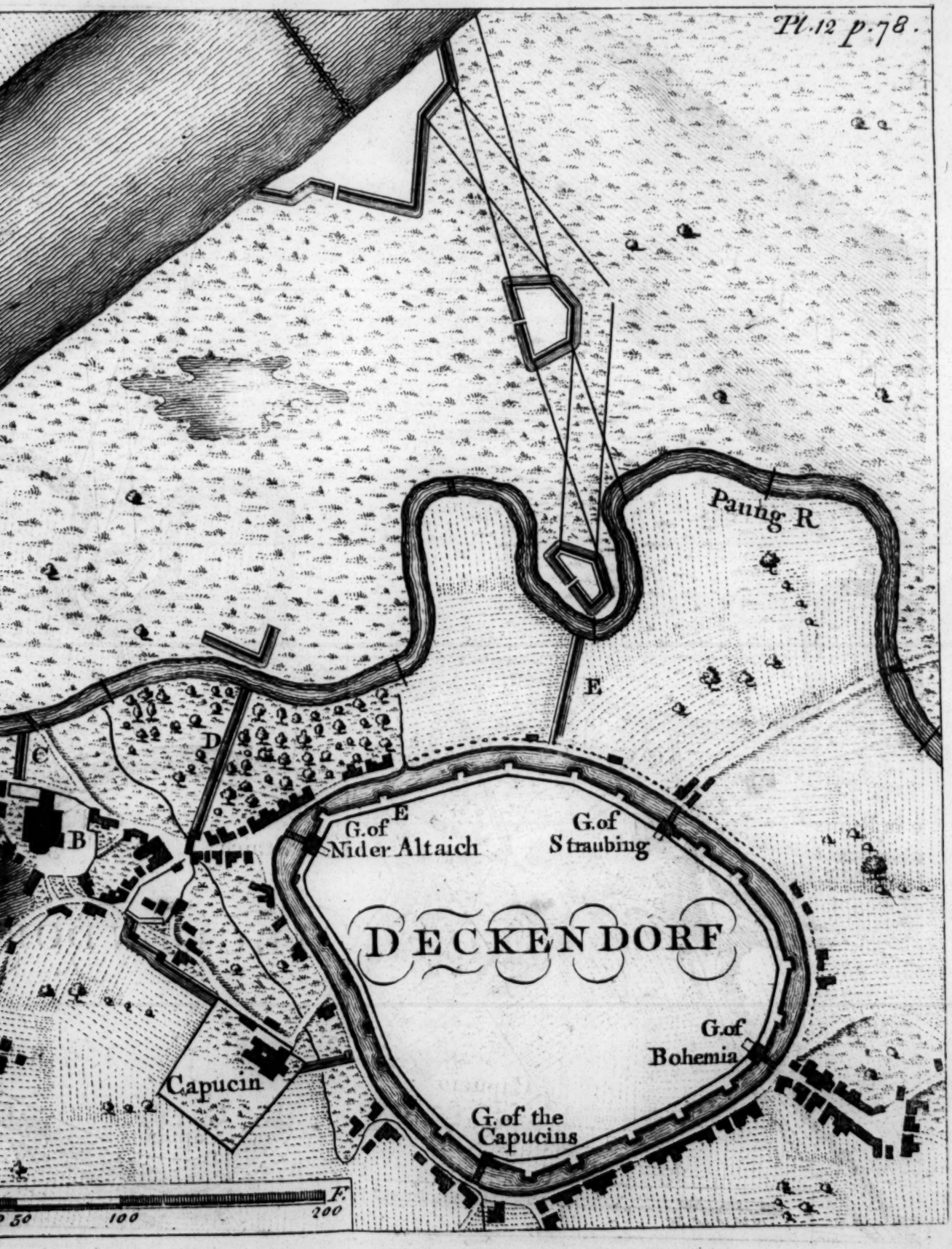
So far from entirely rejecting a method adopted by ſo great a maſter, and ſo univerſally received, I readily allow it is ſufficient, if we ſuppoſe a large train of artillery; in effect, the moſt of theſe inconveniencies diſappear by this means; cannon commonly placed in the redans, make its principal and almoſt only defence, and not firing at random as ſmall arms do, the obliquity of the faces is not ſo great a defect.

We may yet alledge in favour of this method, that a front of 120 fathoms has only 144 of parapet, that is, one fifth more; which is an advantage, eſpecially when we are diſtreſſed for time, want of workmen, or have few troops for the extent of the parapet we ſhould line: yet theſe advantages do not balance the defect of the oblique fires; and ſpaces not raked by any fire, which we are commonly obliged to have in moſt field forts,

ſhould


COMUNICATIONS.
DANUBE
Bridge built 1743
Ovens
A
C
Castle in Ruins
B
ttt
Gof N.D.
10 20 30 40 50 100

Pl. 12 p. 78.


Paung R
F
C
D
B
E
G. of
Nider Altaich
G. of
Straubing
DECKENDORF
G. of
Bohemia
Capucin
G. of the
Capucins
50
100
200
F.

ſhould be regarded as very eſſential defects, and even inexcuſable in all caſes where they may be avoided.

VIII. After this declaration, or rather repetition, I think I may advance my own ſentiments: experience has oft convinced us, that a moderate genius is ſometimes capable of adding, and even perfecting the diſcoveries of a great man; if the reader knew how well I was convinced of this maxim, I ſhould have no reaſon to fear being ſuſpected of preſumption.

I have remarked 4 principal defects in the common method, and ſhall here mention them.

1ſt, The middle of the curtain is not flanked, but at 30 fathoms diſtance in front.

2d, The direction of the neareſt fire does not cut the capital, but at about 50 fathoms from the flanked angle.

3d, The lines of defence being more than 120 fathoms, the fire which exceeds that diſtance may be eſteemed as nothing.

4th, The great obliquity of the redan with the curtain hinders the ditch from being defended.

I greatly miſtake; or a very little alteration will remedy the whole.

It is only to brake the curtain in the middle, ſo that the ſaliant angle ſhall be on a line with the points of the redans, an operation as plain, as eaſy in practice. Plate XVII. Fig. 2.

The angle of the face, with the demi-curtain, being only 98 degrees 14 minutes, the parts reciprocally defend each other every where at a proper diſtance by a croſs fire, and the ditches are alſo defended: the middle of a ſtraight curtain, which we never attac by choice, does not here collect all the fires; they are thus diſtributed more equally, and even trebled towards the ſaliant angles, which are the weakeſt parts.

I cannot here omit one reflection, ſo juſt and evident, that I regard it as a maxim. The quantity of fire that can be drawn from any work, let us do all we can, is deter-

determined by the greatneſs of the extent; it is then only required to diſtribute it equally, or in proportion as the ſeveral parts require; which I think is here done.

Let us ſee at what rate we gain theſe advantages. The front being always ſuppoſed of 120 fathoms, has 154 of parapet, that is, 10 more than the common method; I ſhould alſo remark, that the rentrant angle will not be ſeen, whereas it was diſcovered, at leaſt obliquely from part of the oppoſite face. The connoiſeurs may judge of the importance of this inconveniency, of which I ſhall ſpeak more in chap. 13.

Observations on the ſixth Chapter.

The method of making lines, ſecuring poſts, and intrenching the camp of an army, is here conſidered; alſo the reaſons for and againſt this practice; it is diſputed by military authors, whether an army retrenched, or covered by a line, ſhould receive the enemy in them, or march out and meet him. Many examples are given in favour of the one and the other: but as this is too general a queſtion, it would be ridiculous to ſay that what may be done on any particular occaſion, muſt alſo ſerve on any other: the only way to decide this properly is to come to ſuch particulars, as will enable us to judge, with ſome degree of certainty, when and when not the lines ſhould be defended. When the intrenchment is very extenſive, ſuch as circumvallation lines, and the troops have not an open or eaſy communication with one another, or elſe are confined in their motions, it is very dangerous to wait for an enemy in them, tho' he is much inferior in number; becauſe he makes his approaches in the night, alarms the whole line by ſeveral falſe attacks, to cover or conceal the real: whereby every part of the line muſt be guarded alike; and one part may be carried, before any troops can be ſent to reinforce thoſe who are attacked. Thus the point being carried in 1 place,

place, the defenders fall into confuſion, or ſo diſheartened as to give all over for loſt, and retreat wherever they can. Many examples prove what has been here ſaid; for inſtance, Prince *Eugene* with 18,000 men drove 72,000 *French* out of their lines before *Turin*.

When a general is obliged to be upon the defenſive, becauſe the enemy is ſuperior in number, and in the goodneſs of troops; or to guard a paſs that leads into a country he is to defend; it requires little ſkill to know, whether he ſhould retrench himſelf in an advantageous poſt or not. If a general intends to engage the enemy, but not without having the advantage of the ground, he will naturally pitch upon ſuch a ſituation, where his flanks and rear are ſecure, either by the nature of the ground, or by works that are to be made. As to the front, he will either ſecure it with a good intrenchment, leaving proper openings, ſo as he may march out in a large front, or elſe make ſeveral ſteps, for the infantry to march over the parapet in order of battle, and openings for the horſe only to march out. Sometimes the front is ſecured by raiſing redouts at proper diſtances, with artillery placed in them; or if villages are in the front, they are to be retrenched, and lined with troops and artillery. This M. *Saxe* did at *Fontenoy*; where that village ſtood in the middle of the front, *Anthoin* on one wing, and the woods of *Barray* on the other; the wood was covered with felling of trees, and had a redout in it, and the villages covered by parapets and batteries. When no convenient poſts are to be found in the front, redouts are made, as the *Ruſſians* did at *Pultowa* againſt the *Swedes*; though the laſt took ſome of the redouts, yet the great loſs they ſuſtained from their fire was the occaſion of loſing the battle.

If it is neceſſary to guard a paſs, or a particular poſt againſt a ſuperior enemy, a good intrenchment is then neceſſary; but this cannot be done without a favourable ſituation, ſo as the acceſſible part may be well guarded

and defended, otherwiſe the enemy may form ſeveral attacks, both in front and flank, with a ſuperior number. If there be only one acceſſible part, and that well retrenched, tho' the enemy ſhould force them by their ſuperiority, yet as this cannot be done without the loſs of many men, the advantage will be on the ſide of the defenders, provided they can retire with ſafety. Conſequently the retrenching an army is, generally ſpeaking, advantageous, and oft abſolutely neceſſary.

The chief objections of authors againſt a retrenched camp are, that the army in it is confined in its motions, and cannot come out but in a ſmall front; whereas the enemy, being at liberty, may hazard his motions as much as he pleaſes, without any danger of ſuffering by it, and attac either in one place or other. As to the firſt, it is ſuppoſed the army has ſufficient room for moving with eaſe to what part they find neceſſary; and as to the 2d, the works may be ſo contrived, either to march over the parapet in order of battle, as we have mentioned already, or to leave proper openings from diſtance to diſtance, ſufficient to march out in large bodies: to prevent the enemy from availing themſelves of theſe openings, a traverſe is raiſed inwards, ſo as to cover them againſt the enemy's cannon, or prevent them from forcing their way through them: and for a greater ſecurity cannon may be placed on each ſide to flank them, which being loaded with grape ſhot, will ſoon make them tired of their attac.

Intrenchments or lines are made alſo to cover a place indifferently fortified, and which ſometimes contains the principal magazines of an army, or to cover a conſiderable extent of ground, to prevent an enemy from entering into the country to raiſe contributions. Sometimes an army is obliged to retire before a ſuperior or victorious enemy; in ſuch caſes, by intrenching itſelf near a town or village, for the ſake of quarters for the ſick and wounded, or to form new magazines, becomes neceſſary, provided the place cannot be attacked but

on that ſide; an old wall, or a ſtrong building to place men and artillery may be of great uſe. This is the caſe at *Dunkirk*, which has an intrenched camp on the land ſide, ſurrounded by canals and marſhes, and may contain 25 or 30,000 men conveniently. This camp covers the town entirely, which might otherwiſe be attacked by a ſmall army. Lines have been made in many places of ſeveral miles long, generally covered, in part by large rivers, and from one fortified place to another; but their defence becomes very precarious, except the attack can be reduced to certain places; for ſometimes they have been forced with very little difficulty; and at others, tho' the enemy has penetrated them, yet has been obliged to retire without being able to effect his deſign. The advantages of thoſe lines depend on proper ſituations, the difficulties of penetrating them undiſcovered, and on the capacity of the general who defends them; ſo that nothing certain can be ſaid for and againſt ſuch lines, without being upon the ſpot to ſee what can be done to ſecure them.

The different figures given to lines or intrenchments require particular conſiderations. If an army is already incamped, the engineer muſt make his works conformable to the ſituation, and take care to have ſufficient room between the line and the front of the camp, for the army to draw up in order of battle, in caſe of an attack; the riſing grounds within cannon-ſhot muſt be occupied either by the line itſelf, or by ſome detached works, whoſe communication with the line is ſecure; or if a river is at hand to form an inundation, ſo as the enemy cannot poſſibly drain it: all poſſible advantages muſt be taken that the ground can afford; which requires more ſkill and knowledge than generally imagined; and not to be found, but in an engineer of the firſt rank. As there is no ſituation, but what is ſtronger by nature in one part than another, it is therefore neceſſary to fortify the weak part ſo much more, as to make its approach of the ſame difficulty as the others.

When a poſt has ſome natural advantages, the common lines with redans, at 120 fathoms diſtance (ſuch as fig 1. plate 17.) will be ſufficient; but to ſuch parts as can be approached without any natural obſtacle, ſuch a line is inſufficient. Sometimes the ſame ſort of lines are uſed, with 2 or 3 ditches before them, and the intermediate ſpaces are made full of round holes 7 or 8 feet deep, with ſtakes drove in the middle, as may be ſeen in the 3d plate of my ATTAC and DEFENCE of places; and ſometimes theſe lines are covered with detached works, ſuch as redouts and lunettes. Our author propoſes 2 different methods of making lines ſtronger than the firſt, as in fig. 2, 3. plate 17. they however differ only in the length of the branches, which form the ſaliant angle.

The author propoſes as a maxim, that the quantity of fire or defence that can poſſibly be had from a work, is always in proportion to its extent; and therefore it remains only to diſtribute the fire equally every where, or proportionally to the exigency which ſome parts require, one more than another: this is certainly true, in general, not only in lines, but in all fortifications; but then this maxim cannot always be obſerved; for ſometimes the figure of a line is ſo determined by the nature of the ground, as not to be changed for a better, without falling into ſome conſiderable miſtakes. Suppoſe, for inſtance, a river paſſes before the camp, its windings muſt be followed, otherwiſe an enemy may paſs it, where it is fartheſt diſtant from the line; or, ſuppoſe a bank, or riſing ground, it is plain the ſlope muſt be followed every where, or elſe the enemy may approach under cover; in theſe places, which cannot be flanked by the line, therefore, general maxims muſt be followed, when no other obſtacle intervenes; and conſequently, an expert engineer will chuſe, amongſt the various diſadvantages, thoſe that can be eaſieſt remedied.

CHAP.

CHAPTER THE SEVENTH.

I. *New ſchemes of lines, with redans.* II. *With Tenailles.* III. *More perfect.* IV. *With indented works.* V. *With redans and lunettes, their inconveniency.* VI. *With tenailles, and lunettes.* VII. *With broken tenailles and lunettes.*

I. THE alteration of the forementioned fires of the curtain produce another very conſiderable, which is that each front, being ſufficient for its defence, becomes in a manner a whole front. To explain myſelf.

The front of a fortification, with regard to the defence, is a collection of lines, contrived ſo as reciprocally to flank each other; according to the common method, the curtain only fires right before, and the 2 faces which terminate it, are the only parts that have, or are deſigned to have, this property, the front cannot be complete, that is flanked throughout, if not compoſed of the curtain and 2 faces.

In the new plan, if the face defends the demi-curtain, it is alſo equally defended by it; ſo that ſuppoſing theſe parts were detached from the reſt, and that they cannot be attacked in the rear, they will be capable of ſupporting themſelves.

From thence, we may conveniently give more diſtance from one redan to another, but I would in this caſe alter the conſtruction from the middle of one to that of the next; allow 150 fathoms, that is, 1 4th more, which certainly is the greateſt length to be given: as to the fire of the faces, I would make the capital of the redan (which alſo ſerves as a perpendicular to the brake) 1 5th of the front, and 1 fathom more than half the capital, for each demi-gorge. Plate XVII. Fig. 3.

This fathom is to prevent the flanked angle from being too acute; which, without it, would be only 59 degrees 22 minutes; and now it becomes 63 degrees 24 minutes, that of the face with the curtain 99 degrees 54 minutes, and the length of the face will be more than 28 fathoms.

This method is preferable to the old, by the direction and diſtribution of the fires, and the ſhortneſs of the lines of defence, all points equally eſſential It does not much exceed it in reſpect to work, ſince the extent of the parapet does not exceed the length of the front, but by about 35 fathoms, that is, only 5 fathoms more than 1 5th.

II. Theſe brakes remind me of the manner I traced an intrenchment of about half a league long, at the camp under *Landau*, in 1743: it was not the beſt I ever made, but it is more generous to point out ones own faults than thoſe of others; I need not fear being ſuſpected of magnifying them, and one is leſs embarraſſed for the turn and choice of expreſſions.

I was willing to follow, as much as I could, the ſide of a bank, about 2 feet higher than the meadow, my ſcheme was alſo to bring the river *Quiech* into the ditch. I received my orders on the ſpot, and it was to be traced out immediately.

Plate XVIII. Fig. 1. It occurred to make it in form of plain *Tenailles*, or ſwallow tails, which appeared the beſt, having fewer ſaliant angles, and theſe ſaliants being very obtuſe, were in no danger of being waſhed away by the water.

As to the fortification, I knew that the perpendiculars of 2 lines, which formed a rentrant angle, croſſed each other: I made no farther reflection, and fixing each front at 120 fathoms, the work was quickly picketed out; I forgot what I allowed for the perpendicular; but ſuppoſe about 1 4th of the front, and on this ſuppoſition I will examine my plan.

The

The ſaliant and rentrant angles by this were 126 degrees 52 minutes, conſequently the direction of the neareſt fire, ſuppoſed to ſquare, forms an angle of 36 degrees 52 minutes, with the branch it ſhould flank; ſo that by this obliquity there muſt be 14 fathoms, where it does not touch the capital, and even ſuppoſing it long enough, it would cut it at about 90 fathoms from the ſaliant angle.

I fell then into all the errors I have found in the common lines with redans (except that of the curtain) without gaining any thing more than 10 fathoms of extent by the *Tenaille*, and being leſs liable to be hurt by the current of the water: for giving 8 fathoms more to the perpendiculars, than what is allowed to the capitals of the redans, it is evident I was farther diſtant, at leaſt in the rentrants, from the edge of the bank I wanted to follow.

If the diſpoſition had not been changed, which hindered the execution, I ſhould not have been the laſt to have perceived, that it would not have anſwered my intent; yet I ſhould have diſcovered it too late. How came it about? Becauſe I had not time to trace my plan on paper, to examine the direction and range of the fires; a confuſed notion of the rentrant deceived me; I rejected the common method, deſigning to give ſome lines of better effect, and I made them worſe, or at leaſt very indifferent.

The ſame cauſe has, and will oft produce the ſame effects. On theſe occaſions, we have ſeldom leiſure to draw our plans, which would be a great advantage. A number of maxims, examples, analyſes, *&c.* in this ſcience, would ſupply that defect; but how are they to be obtained? We do not ſtudy this ſubject in fortified places, becauſe the object is not before us, and there are no books that treat of it. As to what we ſee in time of war, fatigue, different applications, and various other cauſes, oft hinder our examining them ſo minutely as to gain any knowledge: beſides, whatever

affinity there may be between field fortification and that of places, the laſt is not ſufficiently clear to explain what belongs to the former.

III. I experienced, as may be ſeen, what I have advanced; for if I had better known the properties of the *Tenailles*, or had time to examine them with my compaſſes in my hand, theſe faults could not have eſcaped me; I ſhould readily have found from whence they proceeded, and perceived that to have remedied them, I need only to have ſhortened the front, and diminiſhed the opening of the angles.

Plate XVIII. Fig. 2.

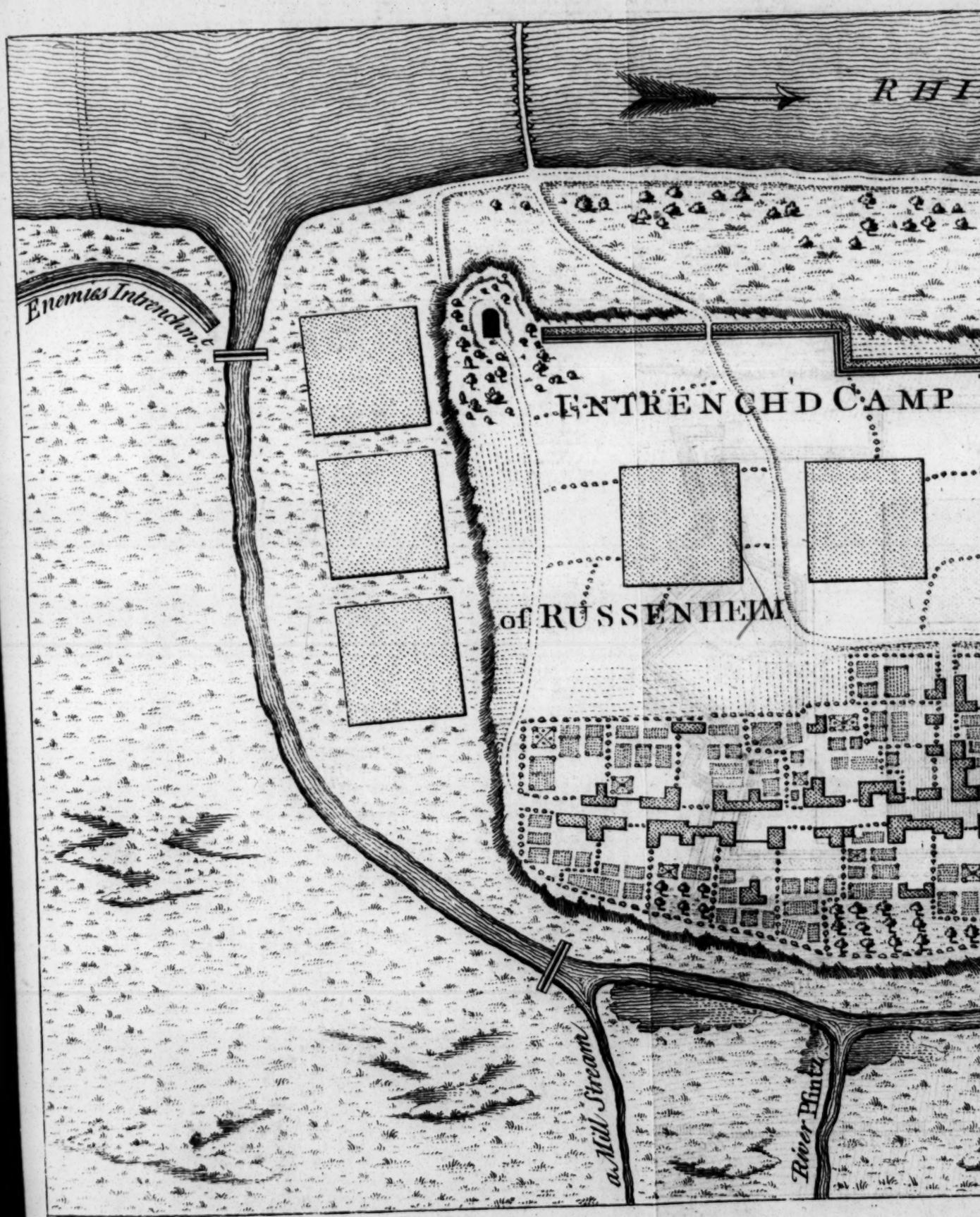
I uſe both theſe means in the 2d plan. The front is but 100 fathoms, and the perpendicular the 3d of the front: the line of defence makes an angle of 22 degrees 38 minutes, with the branch it ſhould flank, and it cuts the capital at 41 ½ fathoms from the ſaliant angle, ſo that the columns of fire of each front, after reciprocally croſſing each other, croſs alſo on a conſiderable part of 1 of thoſe angles, with 1 of the columns of the next front.

The extent of this figure, as in common lines, is only 1 5th more than the right line. I leave the reader to compare the other advantages of theſe methods, and ſhall only add, that this plan would much leſs have anſwered my ſcheme of keeping cloſe to the ſide of the bank, than that I deſigned, as the length of the perpendiculars would conſequently have obliged me to retreat farther from it.

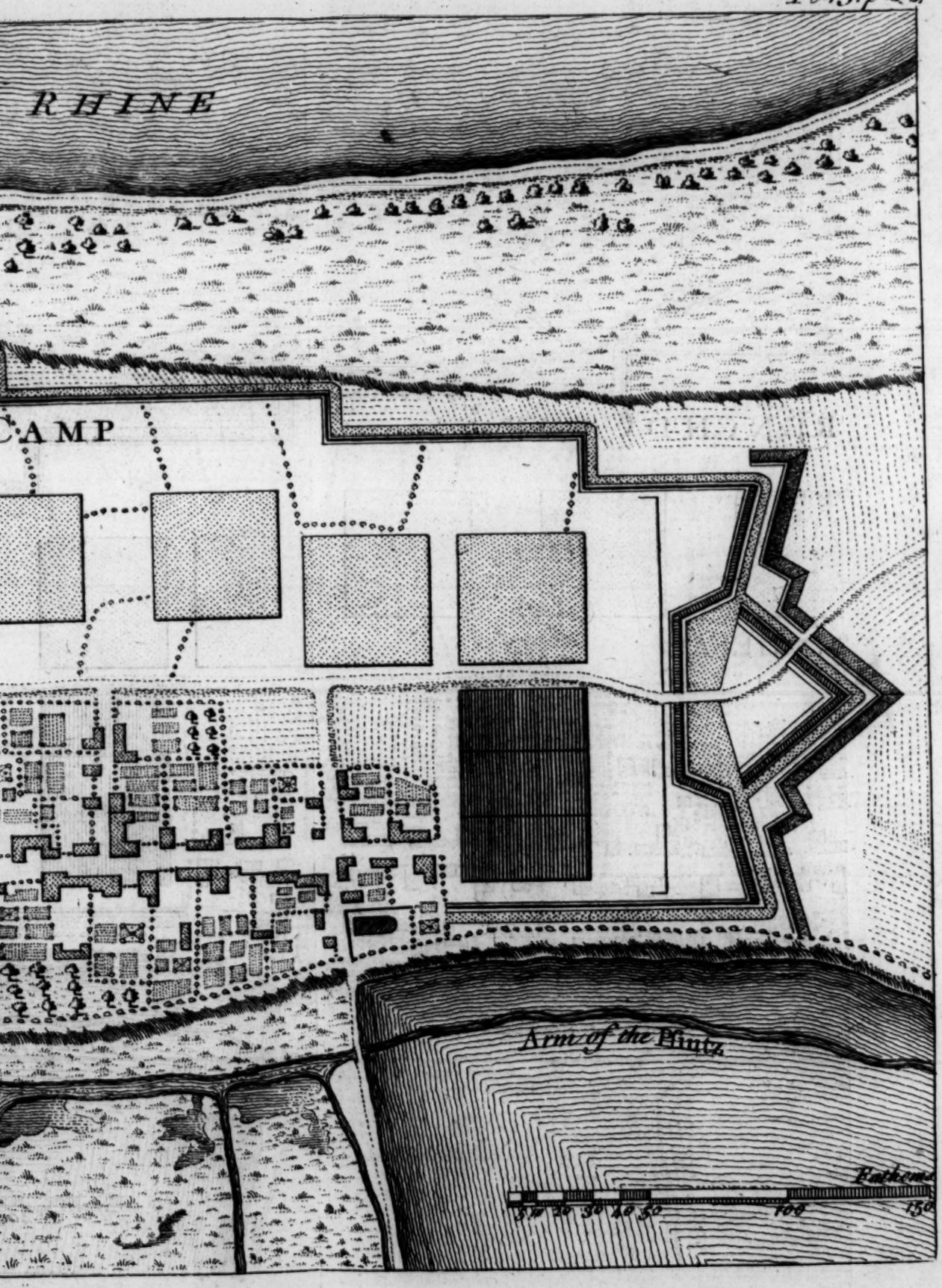
IV. Indented works, ſuch as I made uſe of in the 2d intrenched camp of *Ruſſenheim*, may alſo form a new kind of lines; we ſhall examine their conſtruction, and the effect we may expect from them.

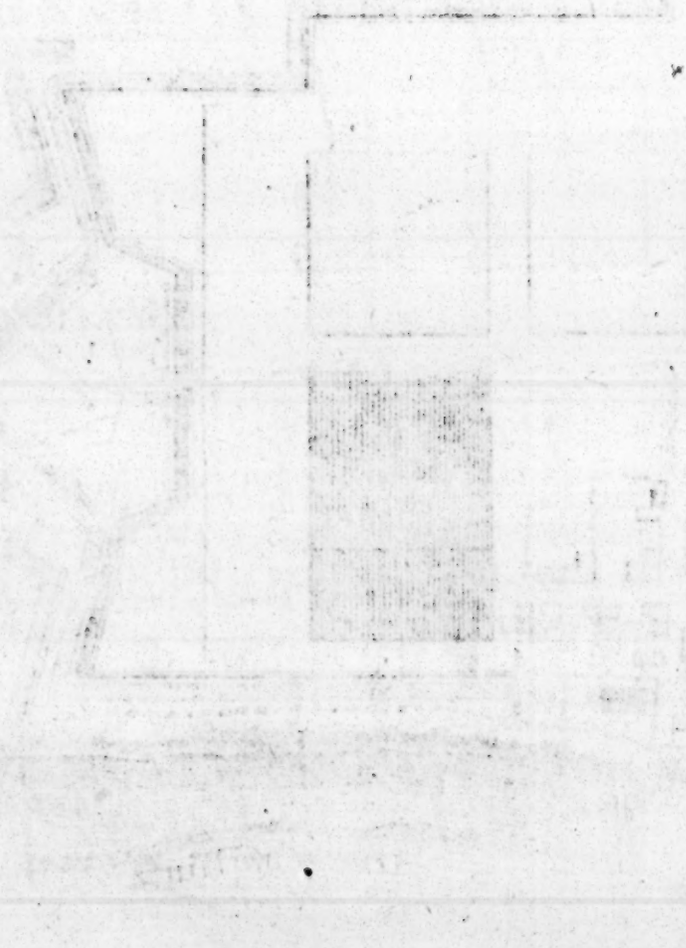
Divide the whole front into parts of 60 fathoms each; let fall a perpendicular from each of theſe points, of 1 4th of that meaſure, that is, of 15 fathoms; draw the branch from the foot of one perpendicular to the ſummit of the next; advance 5 fathoms,

Plate XIX.


RHI
Enemies Intrenchm.ts
INTRENCH'D CAMP
of RUSSENHEIM
a Mill Stream
River Pfintz

Pl. 13. p 88.





fathoms, on the foot of the branch, for the part that is to flank that branch.

The angle of the flank, with the branch, will only be 91 degrees 21 minutes, ſo that the line of defence will paſs but 5 or 6 fathoms from the adjacent flanked angle, and as that will only be near half the range of the ſhot, it will cover the angle of the next branch oppoſite the flank.

Thus there being no part that is not defended by 2 preceding flanks, the length of theſe flanks, which is no more than 14 or 15 fathoms, appear to me ſufficient.

Theſe columns of fire, following each other, and doubling towards the middle of their range, have an uncommon effect, which is ſtill greater, as it muſt be allowed, that when a diſtant defence begins to weaken, it is neceſſary to procure a 2d nearer.

We may alſo reckon among the advantages of this ſcheme, that the ſaliant angles double in number to the common method, and flanked at half muſket-ſhot, advancing very little into the country, are leſs expoſed to the enemy; that on account of theſe ſmall projections, and the ſhortneſs of the branches, it is eaſy to follow a determined line, and to reap all advantages of the configuration of the ground; that it is the only plan, in which a direct fire runs parallel throughout and without interruption, and the only 1, in which the fires are equally diſtributed.

Tho' theſe indents may thus be continued from 1 end of a line to the other, I believe it will be better, for the reaſons I ſhall give, to diſpoſe them otherwiſe, ſo as to form a ſaliant angle by 2 branches, equal to the others, at every 400 fathoms, which ſaliant angle muſt be flanked by 2 redans, and that each extremity be terminated by a baſtion.

I would fix the middle of the gorge of the baſtion 20 fathoms from the point where the extremity of the branch falls on the line; its flanks I would elevate the

ſame

ſame way, and of the ſame ſize as the flanks of the redans; then draw a line from 1 ſhoulder to the other, on the middle of which line, elevate a perpendicular equal to 1 of theſe parts, and the extremity will be the point of the flanked angle, which thus will always be right.

The advantage I here propoſe, is to draw from the flanks of the baſtion the ſame fire from ſmall arms, as from the others, and from the face, where I propoſe artillery, a fire which croſſing in front, ſhould ſerve as the firſt defence to the line.

Hence, the fires of the 4 adjacent flanks croſs before the middle of the 400 fathoms, that is, before the part fartheſt from the baſtions, and conſequently from the artillery, and has moſt occaſion for this aſſiſtance.

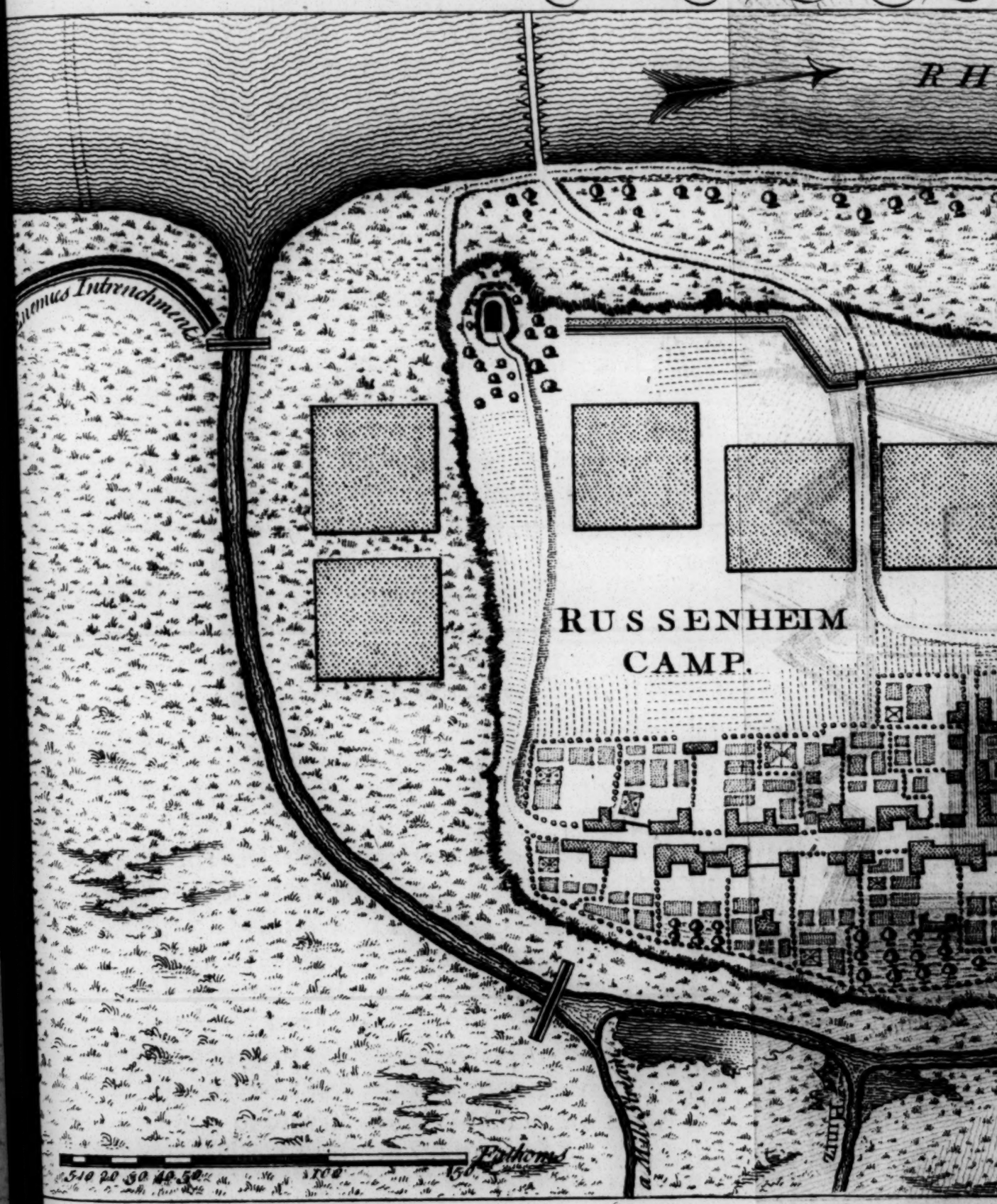
Tho' the faces of theſe baſtions are ſeen leſs obliquely from the curtain, than thoſe of the redans of the common method, I allow they are the moſt defective parts; but beſides their batteries which render them reſpectable, if we would not make the angle too acute, for fear of making them too long, we may render their acceſs very difficult by palliſades, felling, or by breaking the ground in holes or wells.

Suppoſing the line entirely indented, as we did in the beginning of this article, the extent of parapet does not exceed a right line, but by about 11 fathoms 2 feet in 60 fathoms, which is not a fifth; but if we follow this plan entirely, it will exceed between 84 and 85 fathoms in the front of 400.

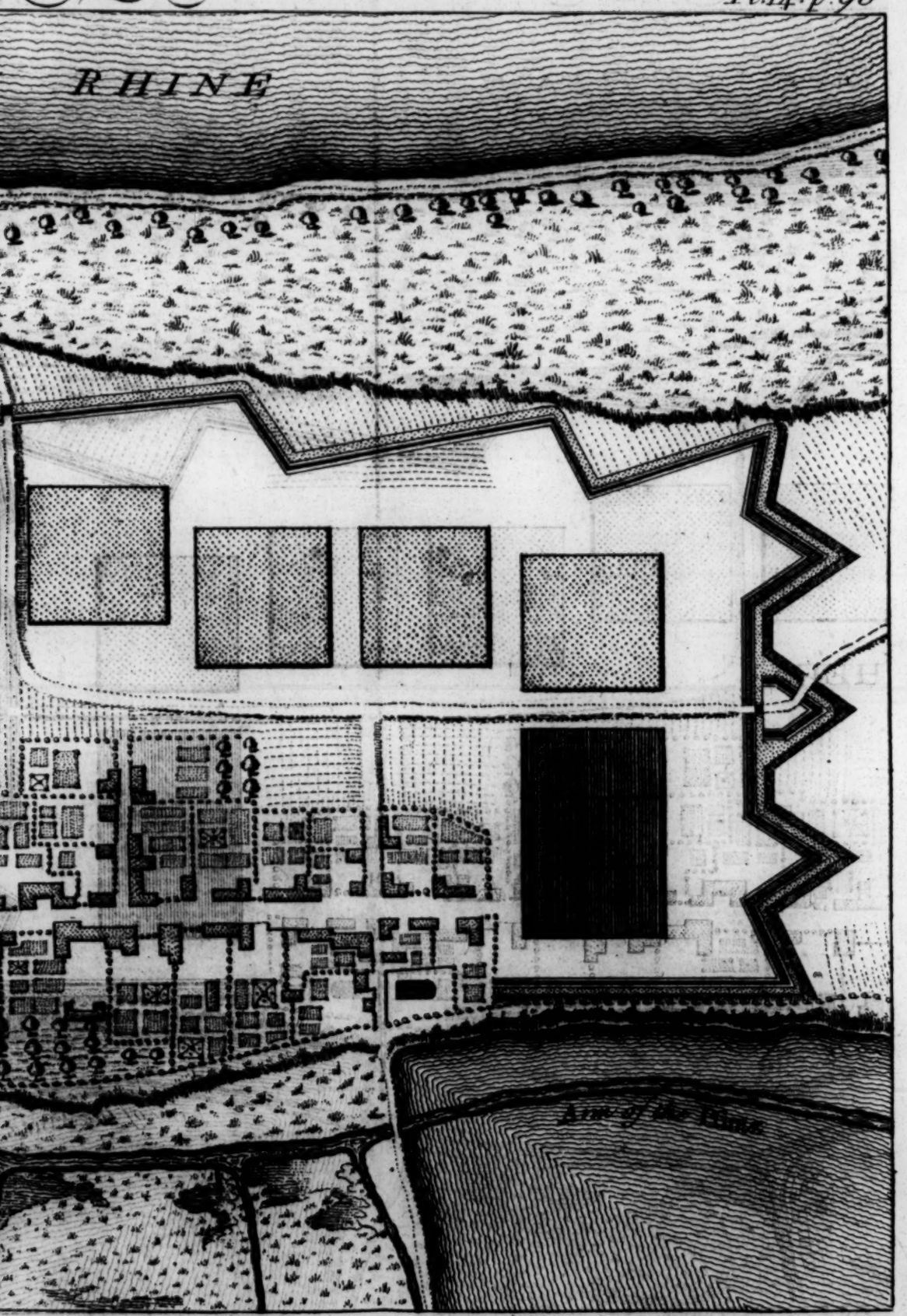
Theſe lines pleaſe me much, were it only becauſe the repetition of the flanks, by their proximity, double the defence, and render it more effectual. I further obſerve, that the artillery being, by its poſition, out of the line, it may if neceſſary graze it, or very nearly; an advantage which none of the beforementioned methods have.

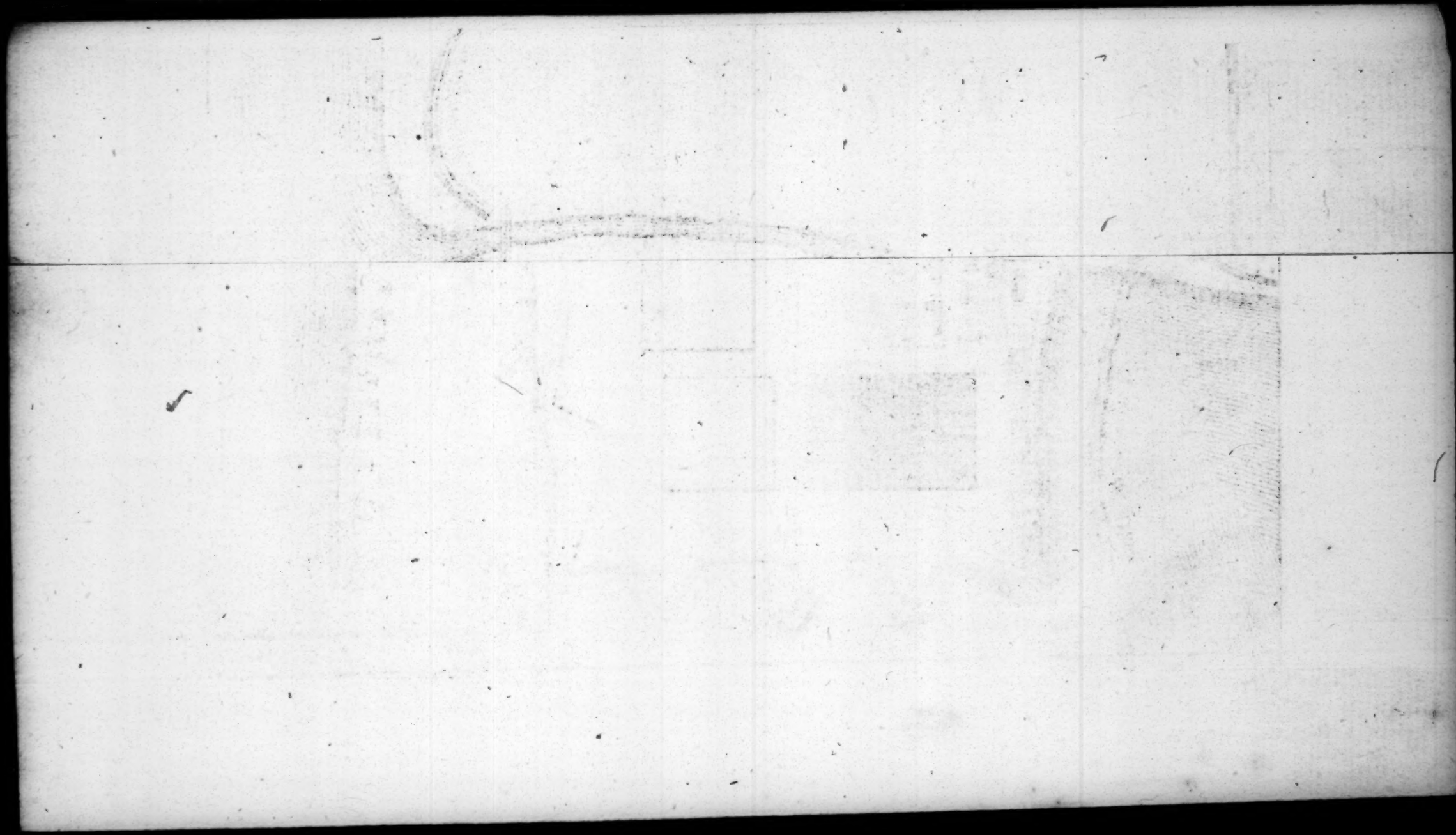
There

2d INTRENCHD CAMP



Pl.14. p.90





There are circumſtances where works are incloſed in the line, to favour the rallying of the troops, if neceſſary: to effect this, it is ſufficient to detach the baſtions, and intrench them at the gorge, but they muſt be conſtructed with a ſtrong profile, and ſurrounded with palliſades, or wells ſunk in the ground.

V. What *Folard* propoſes in his excellent commentaries on *Polybius*, may give an idea of a quite different conſtruction to the preceding 1, tho' the intent of the author was only to ſtrengthen his fortifications by an augmentation of works. "It muſt be obſerved, "ſays he, above all things to make advanced redouts, "or arrows, at every 30 or 40 fathoms, and their com- "munications ſhould be between 2 banks or parapets, "well palliſaded on all ſides, and ſo, that 4 men may "march a breaſt, or in front, between the 2 banquets."

It could be wiſhed, that ſo learned an author had entered into a greater detail on this ſubject, or at leaſt given a plan of his ſcheme; all that can be concluded from thence with certainty is, that he ſuppoſes lines with redans traced in the common method; from thence we may judge of the advantages and diſadvantages of his ſcheme.

We muſt then ſuppoſe a lunette advanced 30 or 40 fathoms before the curtain of 1 of theſe fronts; for it is before the curtain he places them: what is the conſequence? That all, or nearly all the fire of the adjacent flanks, enfilades the gorge, or fires obliquely on the faces. I ſuppoſe, that this diſtance of 30 or 40 fathoms is taken from the gorge, and not from the flanked angle of the work, or elſe the lunette, ſcarcely projecting beyond the ſaliant angles, would not have the intended uſe. Plate XX. Fig. 1.

With regard to the uſual method, if redans are ſo obtuſe, that the lunettes may be defended and not battered, from whence are theſe redans and the curtain to be flanked? Plate XX. Fig. 2.

It is true, the communications fire upon the whole faces of the adjacent redans, in either caſe; and if ſuch works are made before all the fronts, the reſt of the fire will defend the ground, before the communications next to them: this fire is certainly more dangerous to the enemy than to the defenders; yet nothing is more incommodious than to be expoſed to it.

It may therefore be concluded, that theſe lunettes, tho' good in themſelves, cannot poſſibly be uſed with lines traced after the common method.

Permit me to make one ſhort digreſſion, the example of the author I quoted authorizes me. An officer who can converſe well of war in general, if he is not an engineer, has not the ſame force of argument, when he comes to touch on any part of fortification; which equally confirms me in what I have before quoted, *viz.* that it is very dangerous to advance any thing on theſe ſubjects, that we have not proved by ſcale and compaſs.

To return to the lunettes. All the effect we may expect from them, eſpecially from their communications, ſo proper to command in the rear, may be obtained, by finding a method of uſing them without inconvenience.

VI. The whole then conſiſts in flanking their faces, and directing theſe different fires, ſo that they may not be hurtful to the other parts.

Theſe faces have no other protection to afford each other, than a fire greatly advanced before them: they are at too great a diſtance from each other to obtain a grazing defence, therefore it is not from thence we muſt expect what we want.

Plate XX. Fig. 3. One line only, whatever inclination we may give it, cannot flank the lunette and the intrenchment: were we not convinced of the dangers, and ſmall effect of defences badly directed, or very oblique, we could not deny that the directions of

of theſe fires are too ſcattering to part from 1 and the ſame point.

Since then 1 flank is not ſufficient, let us endeavour to obtain 2. Cut the front (ſuppoſed of 120 fathoms) into 2 equal parts by a perpendicular; give 35 fathoms to the brake of the branches; 18 to the demi-gorge of the redan, and 25 to the capital: to conſtruct the lunettes, ſet off 60 fathoms, on the perpendicular produced beyond its interſection with the front line; draw the faces of 25 fathoms long, and ſo as when produced meet the branches within 20 fathoms from their ſaliant angles.

The capital of the lunette will thus be cut by the line of fire, at a little more than 3 fathoms from the flanked angle; ſo that this piece will be defended on each ſide by 20 fathoms, and the branch of the intrenchment by 22 fathoms, of a fire almoſt grazing, which is all that can be deſired.

There remains only the communication to trace; certainly not the moſt eaſy part. The enemy cannot there be well diſcovered but in front, by a part equal to its breadth: beſides, if it is raiſed too much, it is evident it will maſk the fire of the branches, and if ſunk, it will not command enough, and be plunged into from the ground without.

To guard againſt theſe inconveniencies, I give only 15 feet for the paſſage at the gorge of the lunette, and increaſe it to 30 where it meets the front line.

By this obliquity I hinder the fire from grazing too near the ſaliant angles of the retrenchment, and have the advantage of oppoſing an enemy, when entered by the oppoſite extremity, with a front more than double theirs; but as it is an angle, and conſequently cannot afford all the fire neceſſary, I would raiſe a traverſe ſloped in a *glacis*, at the beginning of the communication, and make little branches on each ſide parallel to thoſe of the redan, as in the plan.

As

As to the elevation, I would raiſe the top 3 feet from the ground, and ſink the inſide 16 inches, that is, juſt ſo much as neceſſary to give the parapet a proper height; the ſummit muſt be flat, without bent or ſlope, that the fire may horizontally graze the country.

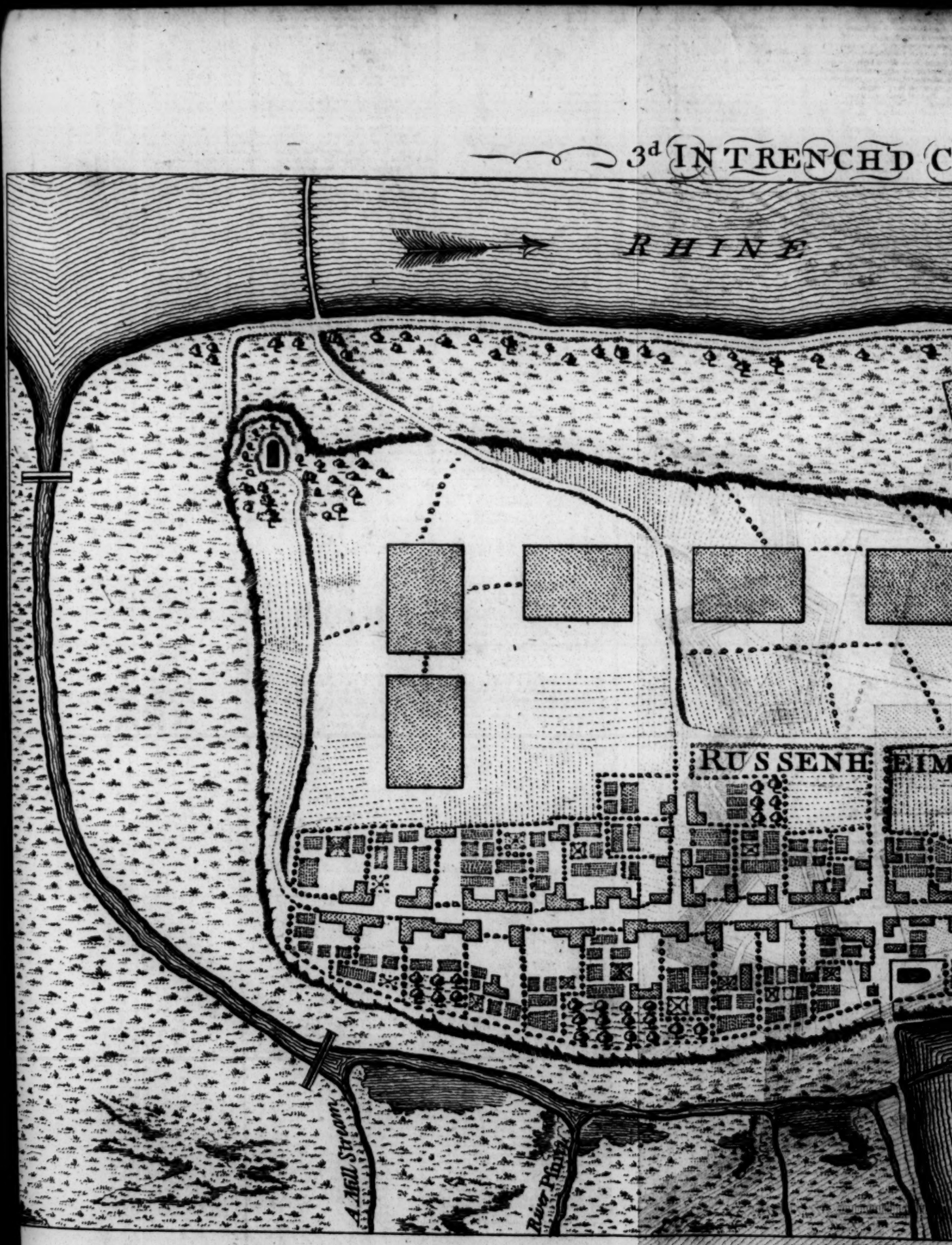
2 different motives make me here reject banquets; 1 is, as we cannot give them leſs than 4 feet in breadth, including the ſlope, the communication would by this means be widened 8 feet, and conſequently more expoſed to the fire in the rear; the other, that the leſs the communication is covered, the more it will be plunged into from the branches of the intrenchment.

It is impoſſible to hinder 2 lines, parallel to each other, from battering one another at right angles; therefore 1 communication always fires on the next, and I know no other remedy, but to place lunettes at every other front only. Theſe flanks would then ceaſe to be dangerous to each other, and would protect the intermediate front by a reverſe fire, which may be ſhortened ſome fathoms, if we would have it better defended.

VII. Theſe kind of lines is already ſufficiently complicated, yet when we have more time than neceſſary for the eſſential diſpoſitions, and the troops not fatigued with ſervice, it may be prudent in a general to find methods of prolonging their employment; beſides the utility that would reſult from this for the ſecurity of the camp, it is certainly the moſt agreeable method of preventing deſertion, ſickneſs, and the diſorders, which idleneſs expoſes a ſoldier to: ſo important a ſubject requires a ſerious attention.

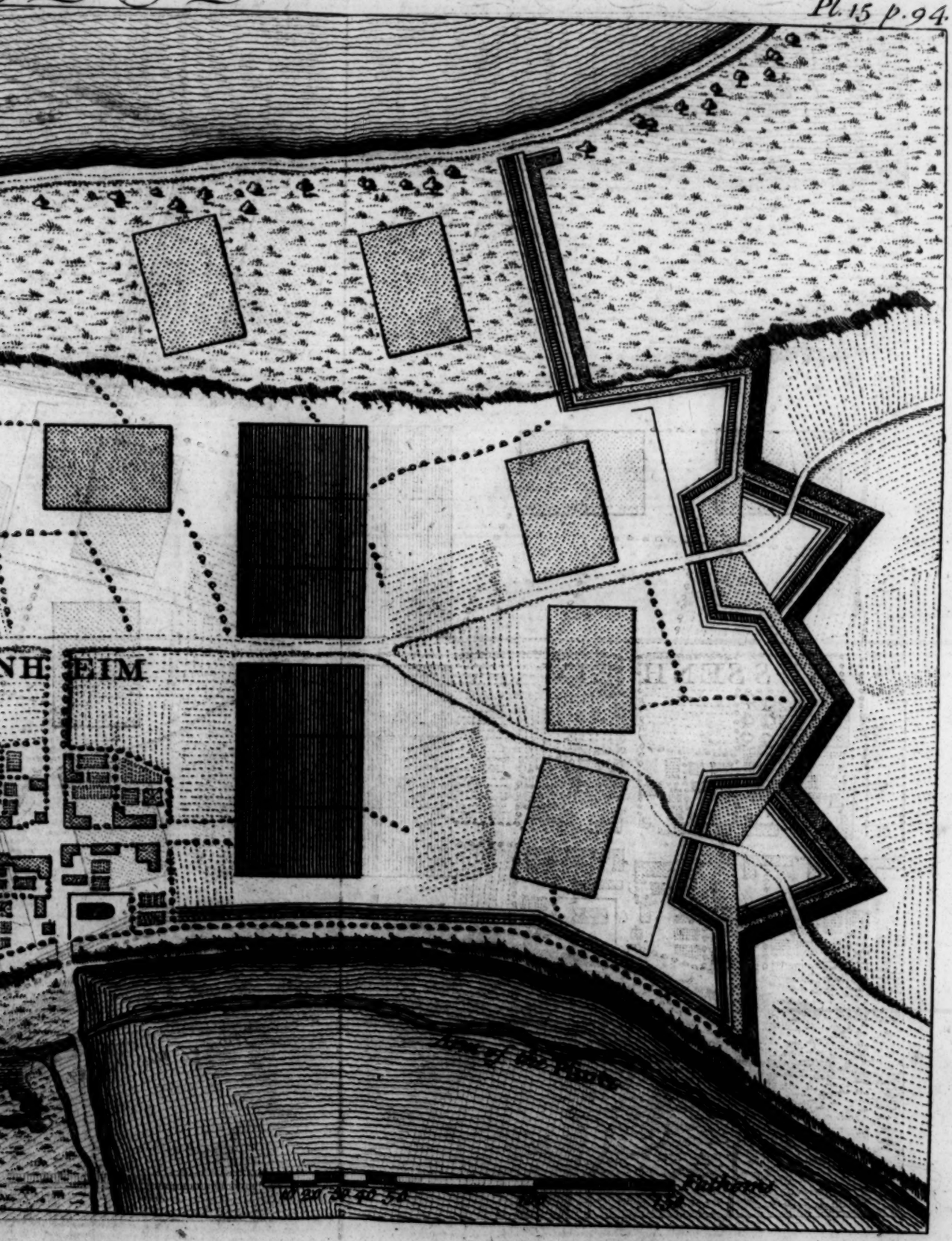
Theſe ſchemes, ſpeculative as they appear, may be difficult to put in practice; or if they have faults equal to thoſe of the common method, or even more eſſential, it will be always neceſſary to mention them, to give them their full career, and ſhew what variety a ſubject, hitherto treated in ſo plain and uniform a manner, is ſuſceptible of. I would therefore propoſe the

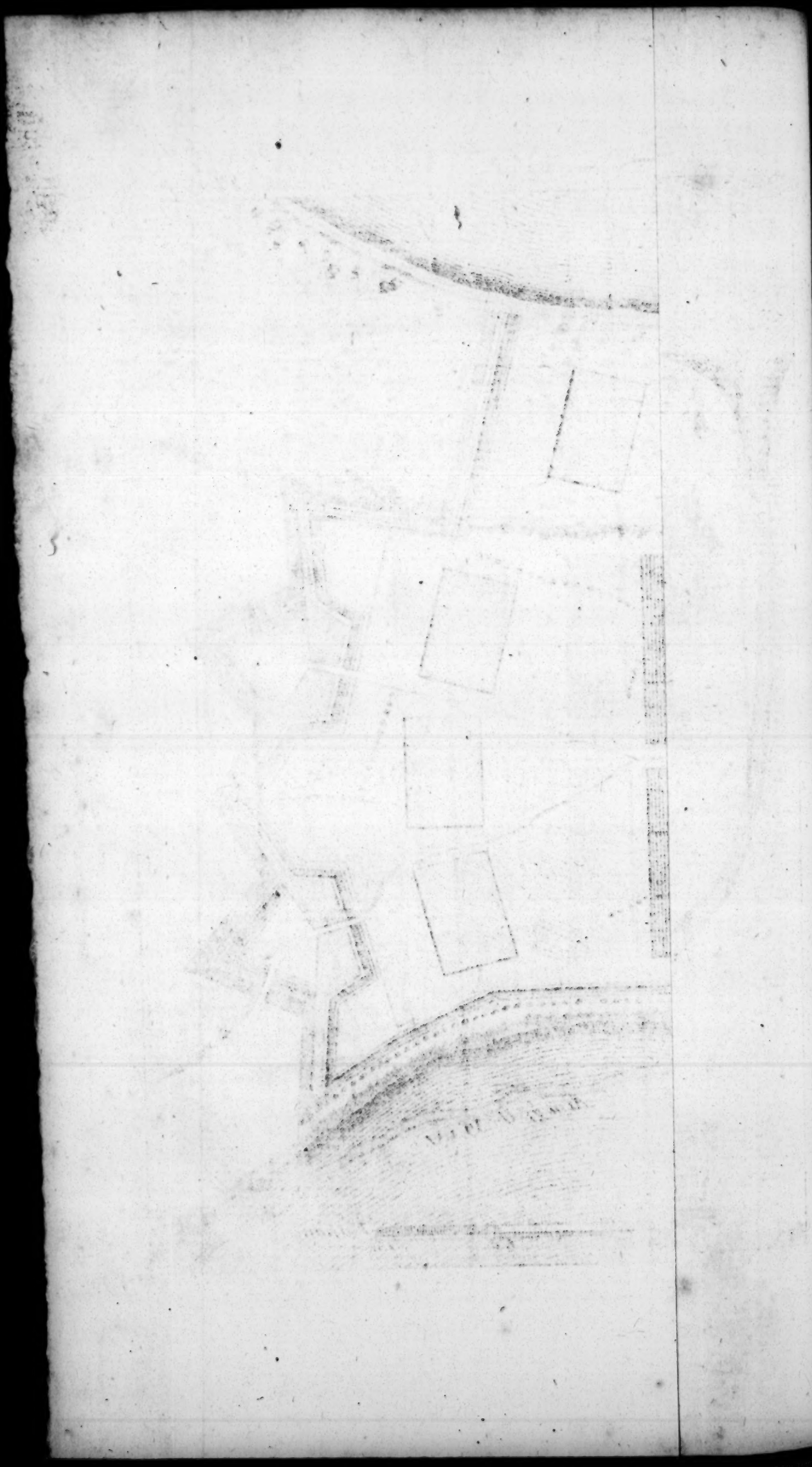
enlarge-


3d INTRENCHD C
RHINE
RUSSENH
EIM
A New Sconce
River Rhine

CHD CAMP.

Pl. 15 p. 94.





enlargement of the work in view, tho' it were as conſiderable as it is otherwiſe.

The figure being traced as before, except the redan, which is here left out, draw a line of defence from the flanked angle of one of theſe branches, to a point on the other, 45 fathoms from that branch; from a point, 20 fathoms on its extremity, let fall a line perpendicular to the other line, which will be the flank; this point at 20 fathoms alſo ſerves for the direction of the faces of the lunette. Plate XX. Fig. 4.

This alteration is trifling in itſelf, it is no more than a brake of 25 fathoms baſe, yet produces a very great one in reſpect to the fires: according to the firſt plan, thoſe of the branches croſs all on the rentring angle, they cover it entirely with a parallel fire, and are croſſed by that of the redan; but we are obliged to leave one ſpace vacant, that would batter the lunette. According to the other, a different direction is given to a conſiderable part of the fire which is directed towards the flanked angle: for the fires of the new brake, the one part cutting the capital of the ſame branch, and the other grazing the oppoſite ſaliant, croſs with the other defences.

We here employ all that ſpace, which for fear of firing on the lunette, we were obliged to leave vacant in the firſt plan: this circumſtance, that eſpecially of the 2 additional columns of fire, which cover the ſaliants, ſhould recommend this plan, as well for uſing lunettes, as for forming a plain intrenchment.

This does not prevent us, even in the caſe we are ſpeaking of, from making good uſe of the other. We ſhould, as I obſerved, only place theſe advanced works in every other front, and the intermediate front will be very well traced after this plan. The large columns of fire which cover the rentrant, ſerve as a lunette for its ſecurity; the ſaliant angles will be well defended, ſince being common to the adjacent fronts, they will be croſſed by 4 columns of fire.

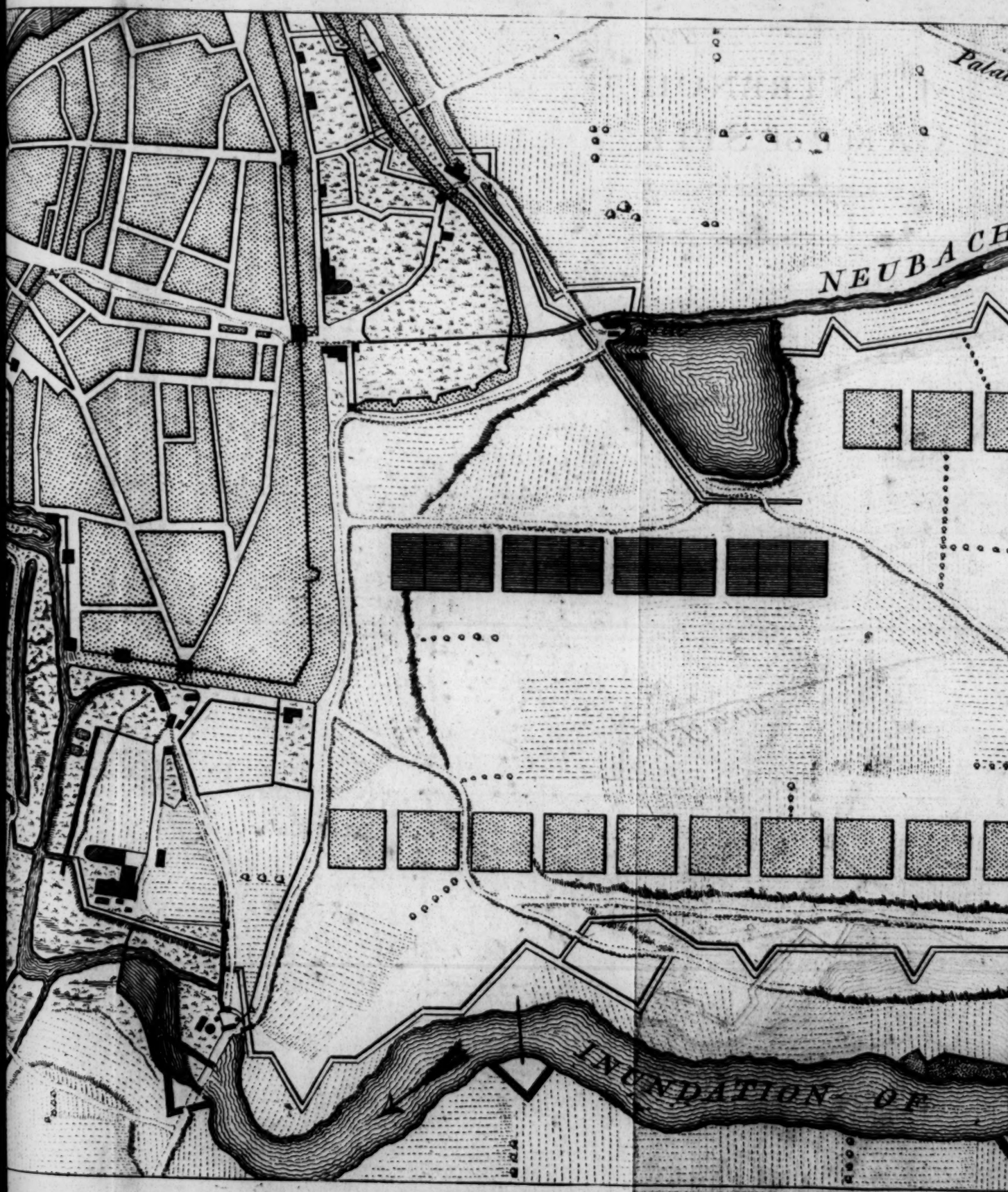
It appears then by the broken *Tenailles*, and by the double and treble flank, that this branch of military architecture, is as capable of producing as ſtrong fortifications as that of places.

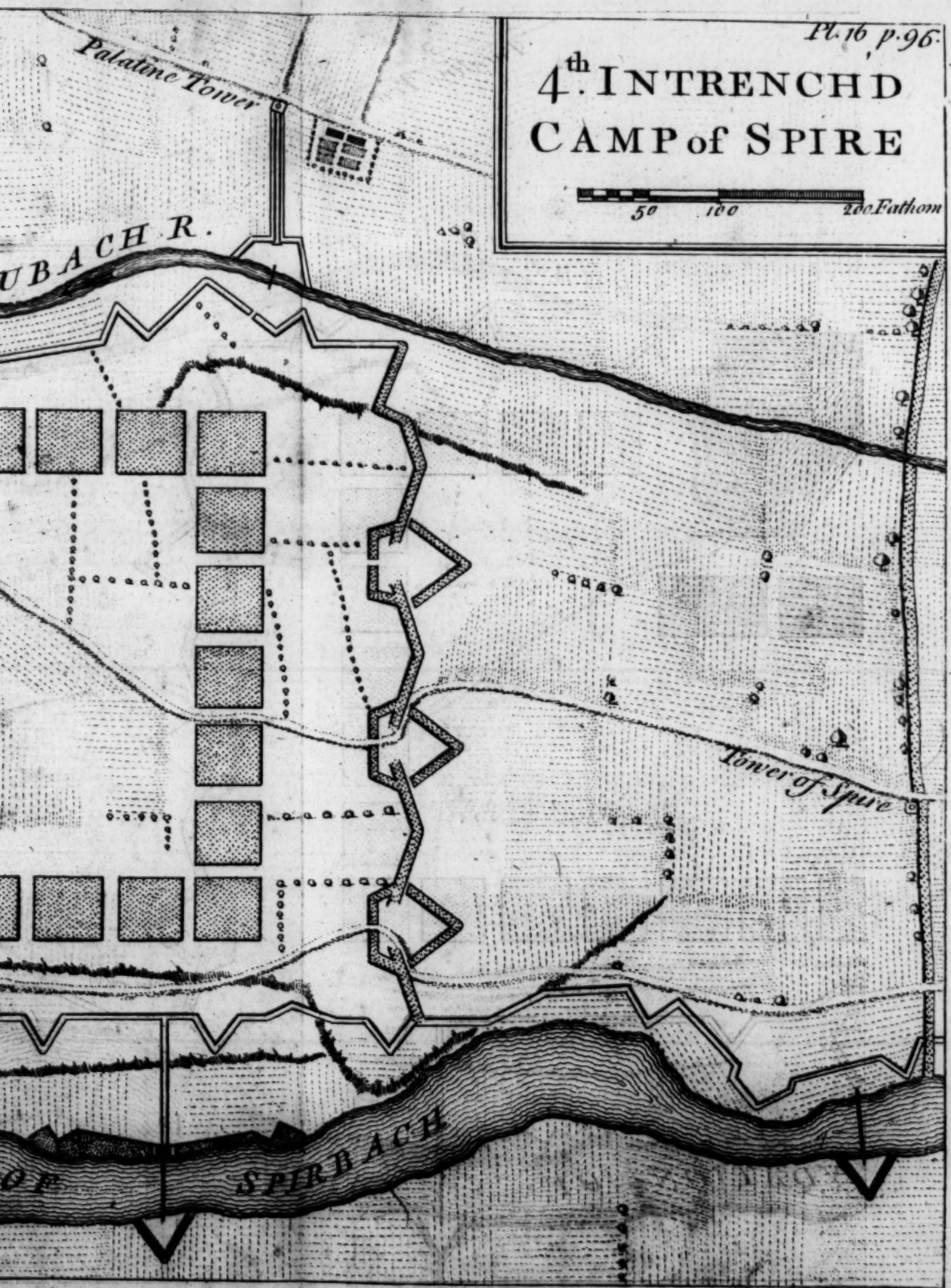
Observations on the ſeventh Chapter.

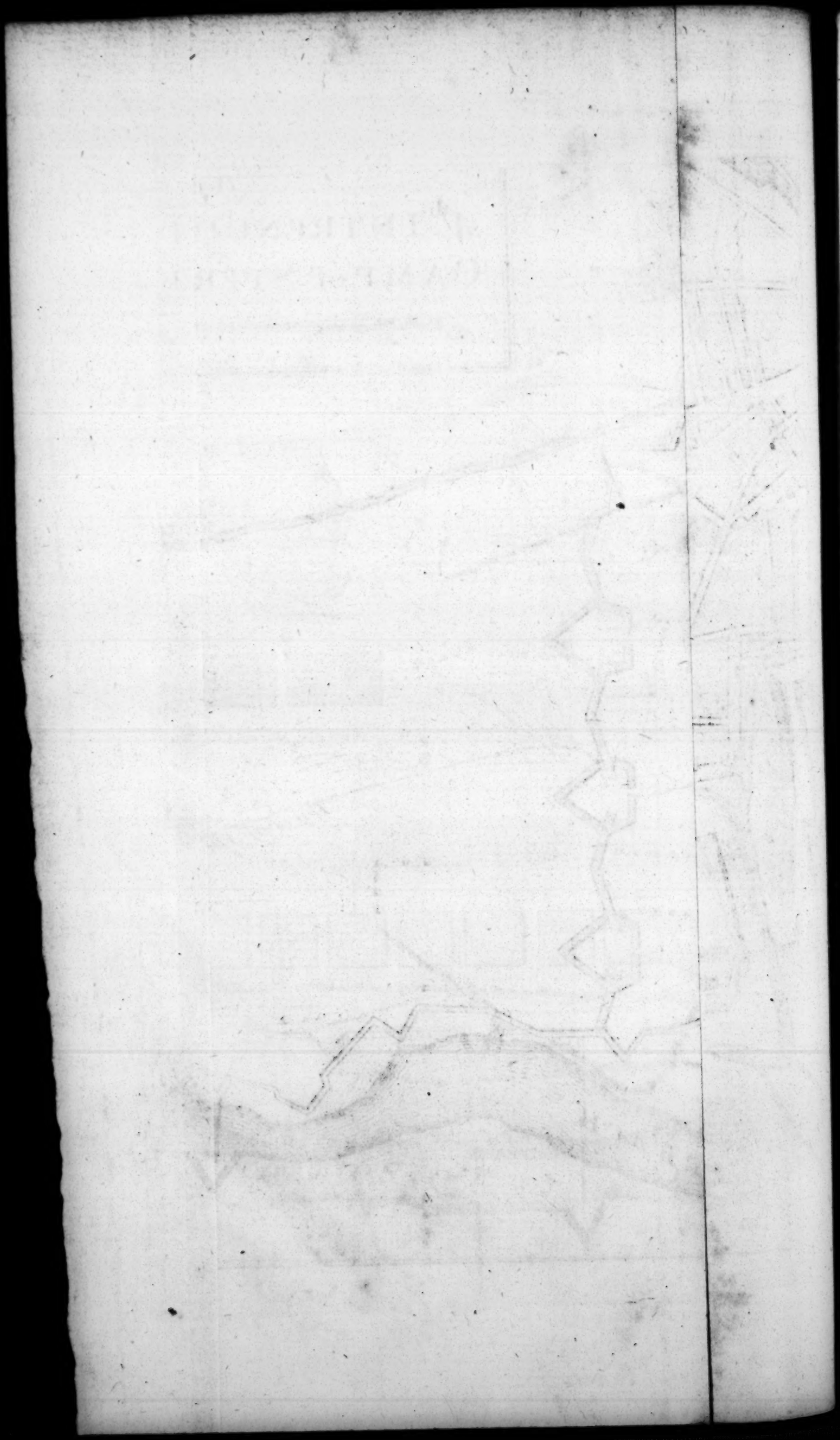
The various methods of conſtructing retrenchments, according to the different ſituations and circumſtances, is the ſubject of this chapter. The author endeavours with candor to diſcover the advantages and diſadvantages attending ſome ſorts of works, not even ſparing his own miſtakes: the figures in plate 18, are proofs of his impartiality; theſe were works he intended to make, being in a hurry, and not having ſufficient time to conſider their forms, he ſays, had they been executed, they would have fallen into all the defects of the common conſtruction. It is ſeldom that an engineer has time to make a deſign of his project; without which, the author is of opinion, defects can ſcarcely be avoided; not conſidering that more is requiſite than what can be learned by practice. To conceive a true idea of lines variouſly conſtructed, they ſhould be traced on paper, and examined leiſurely, either in winter quarters, or when nothing elſe is to be done in the field. When an engineer is once upon a ſpot of ground to be fortified immediately, he ſhould at firſt ſight, know how to trace the different parts, ſo as to make the beſt defence circumſtances will allow.

Plate XVIII. The author, with little reflection, might eaſily have ſeen, without tracing the works on paper, that by making lunettes before the rentring angles, cloſe to the ditch, whoſe faces being perpendicular to the branches; theſe very lines, imperfect as they now appear, would then have had all the defence he could have deſired, and have taken up the high ground between the line and the river.

Having ſhewn the little defence theſe lines are capable of, he gives ſome in plate 19, which are of a more perfect


NEUBACH
INUNDATION OF


Pl. 16 p. 96.
4th. INTRENCHD
CAMP of SPIRE
50 100 200 Fathom
Palatine Tower
UBACH R.
Tower of Spire
OF SPIRBACH



perfect conſtruction; their ſides are indented, and form a ſaliant angle in the middle, with baſtions at the angles of the polygon. It is certain, that the middle part of the front is ſtrongly defended, but the baſtions have no defence that I can find; and as the enemy will make their approaches in the capitals of the baſtions, as being the weakeſt part, and not in the middle of the front, as the author ſuppoſes, all this great defence is of no conſequence. It is ſtrange, that the author ſhould neglect the moſt eſſential maxim in fortification, *viz.* to make all parts equally ſtrong, and on which the true art of fortifying irregular places intirely depends. He ſeems to be ſenſible of this defect, and pretends to remedy it, by placing artillery upon the faces of the baſtions, and felling trees, or making pits with ſtakes in them; but ſuch trifling obſtacles as theſe are ſoon removed, unleſs they are ſupported by a ſtrong fire, which is not the caſe here; nor can the artillery be of any uſe, except it was placed upon the adjoining parts of the branches, where indeed it might flank the baſtions, tho' very obliquely; after all that can be done to remedy theſe defects, this conſtruction is, in my opinion, not ſo advantageous as thoſe marked fig. 2. and 3. in plate 17, tho' the work is greater, and the conſtruction more intricate.

In plate 20, are different conſtructions of retrenchments, of which the firſt and 2d are imitations of M. *Folard*, which our author thinks are not ſo well explained, as ſo able a writer might have done; and therefore he ſuppoſes the common conſtruction as to the lines themſelves; in regard to the lunettes, they could not well be nearer the curtains than he has placed them, becauſe they would not elſe anſwer the ends propoſed, as projecting but very little before the other works: and if they are placed in this manner, the fire of the adjacent flanks will enfilade their gorges, and defend the faces but obliquely.

It is not ſo much the ſituation an author chuſes to place a work in that is to be conſidered, as that which the figure or nature of the ground requires: therefore theſe lunettes ſhould, in my opinion, be placed ſo near the curtains, as to defend the faces nearly directly, and ſo conſtructed, as to be reciprocally defended by theſe faces: in this caſe the works would be as ſtrong as their nature will admit of: as to the lunettes not projecting before the other works, it is rather an advantage than otherwiſe; ſince the defence of a work weakens in proportion as it projects beyond the reſt; and it is always at the moſt ſaliant part where the enemy makes his approaches. This however ſuppoſes the ground to be every where even, or upon a level; but when a riſing ground happens to be before a part of the line, that might be an advantage to the enemy, either by making his approaches there under cover, or if he ſhould get poſſeſſion of it, to raiſe a battery, or a fort to annoy the trenches: it is then of the utmoſt importance to raiſe a good detached work there, and to make a ſecure communication from it to the line. The author makes a digreſſion as to the abilities of officers, in reſpect to engineering; where he ſays, tho' an officer writes ever ſo well upon the different parts of the art of war, which he had an opportunity to know by experience; yet when he comes to treat upon fortification, what he ſays cannot always be depended upon; which is as much as to ſay, that engineers only are qualified to write upon fortification. Though an officer may perhaps not be ſo well acquainted with all the minute particulars; yet, as it is his duty to underſtand how works are to be defended, and how to intrench himſelf upon particular occaſions, if he is otherwiſe qualified, he may write upon that part as well as an engineer.

The 3d fig. in plate 20, repreſents the ſame work as the 2d figure in plate 17, with this difference only, of having a lunette before the redan; for what reaſon he places this lunette ſo far from the redan is not eaſy to be

be gueſſed: for if their faces were only about 5 or 6 fathoms from thoſe of the redans, and perpendicular to the branches which form the ſaliant angle of the line, they would defend theſe branches, and reciprocally the branches would defend their faces, each other at right angles, which is the greateſt advantage they can have, according to the conſtant maxim of fortification. I ſuppoſe the author thought, that if the lunettes were placed ſo near, they might prevent the faces of the redans from defending the branches: this they certainly would; but as the defence of the faces of theſe lunettes is at right angles, it is no more than to change an oblique fire for a direct: beſides the lunettes being ſo near, they could not be taken, as being ſtrongly defended by the redan, and the enemy would be reduced to attack the ſaliant angles of the line, which being defended by a direct fire, would make all the reſiſtance that is poſſible. Beſides the difficulties of making the communications, which the author imagines to be none of the leaſt, would be entirely avoided.

The author propoſes to make an additional flank by the broken curtain, as in fig. 4, plate 20; though this produces an additional fire to the defence of the baſtions; it is very inconſiderable, ſince it reaches their capitals but at a great diſtance, and obliges the lunettes to be placed too far from the curtain, which, in my opinion, is a conſiderable defect; for as their faces protect the capitals of the baſtions but very little, and at a diſtance, the enemy, by attacking theſe capitals, after paſſing the faces of the lunettes, may take them by the gorge with all the troops in them, with very little trouble, notwithſtanding the defence of the communication, which can be no more than one diſcharge of ſmall arms. To render this conſtruction as perfect as could be wiſhed, I would make that part which forms the rentring angle of the curtain in a right line, and place the lunettes cloſe to it, and make their faces at right angles to the faces of the baſtions produced; or if the

ſaliant angle of the lunettes ſhould become too acute, to make it ſomething more open: by this correction all the works would defend each other, nearly at right angles, which is all that can be deſired, and the labour of making them would alſo be leſſened.

When every eſſential precaution to ſecure the camp has been taken, ſays our author, and time as well as leiſure permits, it may oft be prudent for a general to employ the troops in ſome work or other, merely to prevent idleneſs, as being the mother of all evil: but as all uſeleſs works are ſuperfluous, and unneceſſarily to fatigue the troops is an idle notion, it would be more conſiſtent with reaſon to add ſuch work, as might ſtill more ſtrengthen the camp at a time of leiſure: ſuch, for example, as a 2d ditch, and to fill the interval with pits, having ſtakes drove in them, eſpecially before the ſaliant angles, or where the enemy might attack and penetrate with more facility than any where elſe. Beſides, many other works might be made, ſo as to be a further ſecurity; and the ſoldiers would not think their labour loſt, if they were convinced that it tended to their own preſervation.

CHAPTER THE EIGHTH.

I. *Lines with baſtions after the common method; their defects.* II. *A new and more perfect method.* III. *Schemes of lines with detached baſtions.* IV. *With detached works.* V. *Lines detached in parts.* VI. *Works to be made for a day of battle.* VII. *Example of their uſe at the battle of* Fontenoy. VIII. *Lines joined to works cloſed at their gorge.*

I. THE inſufficiency of redans for the defence of a line happens, as we have ſhewn, from the great obliquity of their faces: ſuppoſing the curtains ſtraight, we cannot remedy this but by flanks, and

to

to add flanks to theſe pieces is actually making baſtions.

We gain by this an additional fire of the flanks, for that of the faces croſſing in front, ſerves inſtead of, and exceeds that of the redans; the extent of the figure produces this advantage in one reſpect, the reſt depends on the curtain, which is not weakened by it, as it is ſhortened in proportion.

This made me reſolve to baſtion the intrenched camp at *Ruſſenheim*, and that of *Spire*. I ſhould have ventured this novelty with much more aſſurance, had I known myſelf ſupported by ſuch an authority as the *Marquis de Santa Cruz*, but his book had not then appeared in *France*. "To flank an intrenchment, ſays "he, ſpeaking of that of an army, I would not con- "fine myſelf to ſaliant angles, whoſe defences are ob- "tained under very obtuſe angles, by which the de- "fendants are greatly troubled: but I would form "baſtions."

Theſe kind of lines is certainly better, and at the ſame time more beautiful than that with redans, ſuppoſing, however, that there are other real beauties than what are uſeful. We may then wonder that they were neglected, even to appear unknown, before the ſiege of *Philipſbourg*; they were the firſt and only of that kind that I had ſeen.

I traced one part of them which had 130 fathoms front, 25 perpendicular, and 35 for the faces, the flanks were perpendicular to the lines of defence. Plate XXI. Fig. 1.

Being acquainted only with theſe, I ſhall give no others for examples; and as my ſubject has obliged me rigorouſly to examine the common conſtruction of redans, I cannot diſpenſe doing the ſame here.

Theſe conſtructions have this in common, that the curtain is covered by ſo much fire, as to become in ſome manner inacceſſible: this apparent advantage is no defect in itſelf, but neceſſarily produces one. The

fire a front can furniſh, being always proportionable to its extent, if we direct too much towards one part, another muſt want it: great care therefore ſhould be taken to diſtribute it equally throughout, having regard to where there may be the greateſt occaſion for it; but that is not done here, the curtain, the moſt rentring part, of courſe the ſtrongeſt in itſelf, reaps almoſt all this defence; and the parts moſt ſaliant, and conſequently the weakeſt, that is, the faces, have none at a diſtance from the angles, and are not flanked, but very near, and for a ſmall breadth.

Hitherto theſe defects have not been much regarded, perhaps they have been thought inevitable, as being nearly the ſame as thoſe of common lines; be this as it will, they do not appear leſs important than thoſe already mentioned.

The firſt objection is, that the ditch being parallel throughout to the principal line, the counterſcarp muſt hide one part, ſo that the enemy in the ditch cannot be diſcovered from the oppoſite flank. I have before mentioned this inconvenience.

The 2d, not quite ſo obvious, was made to me by *M. de Cormontaigne*, an engineer of great abilities and reputation; it is, that the enemy, maſters of a baſtion, but yet too weak to march forward, will be diſlodged, or driven back, with great difficulty; having their flanks covered by thoſe of the work, they can only be attacked in front, and by a leſs front in proportion to their's and the number of their troops, than in a redan; becauſe of the ſmallneſs of the redans and the great obliquity of their faces. I ſhall examine this obſervation with all due care and attention.

II. The greateſt defects of theſe lines, being nearly of the ſame kind as thoſe of the common method, we may remedy them by almoſt the ſame means.

Plate. XXI. Fig. 2.

I always ſuppoſe the front 120 fathoms. Give 1 5th to the perpendicular; make the faces half the lines of defence; included by

by their interſection and the flanked angles; let fall the flanks ſquare on this line, and thus form a broken curtain.

The figure ſhews that we thus gain 2 additional columns of fire on the capitals, and that there is more left for the curtain than neceſſary for its defence.

As to the cover which we find in part of the ditch of the faces, towards the angle of the ſhoulder, I know no other remedy than what I recommend for the intrenched camp of *Spire*, and luckily that is ſufficient. The dangerous part of the counterſcarp muſt therefore be taken away to about 3 feet from the bottom: for example, if the ditch be 7 feet deep, the ſide is ſloped for 4 feet, in form of a *glacis*, which muſt be ſo directed, as to be grazed by a line drawn from the ſummit of the parapet, to the point where the ſlope begins.

The firſt difficulties being ſurmounted, I paſs to the laſt. The redan and the baſtion ſuppoſed cloſed at the gorge, reckoning from the principal line, the firſt contains 330 ſquare fathoms, and the baſtion 1770 $\frac{1}{2}$: one of the gorges is 30 fathoms wide and the other 76 $\frac{1}{2}$.

To attack the enemy with equal advantage we muſt occupy a front more than 5 times larger before the baſtion than before the redan, in regard to the number of troops they can contain; but as we muſt only conſider the extent of their front rank, this is reduced to little more than twice and a half.

Theſe fronts may be compared. Form a right angle triangle without, on the gorge of the work; on each of the ſmall ſides, at their extremities joining the *hypothenuſe*, elevate a perpendicular 60 fathoms long, from the middle of the gorge, and with this radius deſcribe an arc of circle, and the fronts will be formed by chords. Plate XXII. Fig. 2.

I ſuppoſe all the fire contained in this part of the circumference, becauſe the obliquity of the ſhot beyond theſe extremities would not ſufficiently enter the work.

We ſhall then find in the redan 5 fronts, which may be advantageouſly placed in that ſpace; 1 that is equal to the gorge, 2 equal to the ſmall ſides of the right angles triangle; and 2 others larger than theſe, and ſmaller than the firſt.

The baſtion affords but 3, 1 equal to the gorge, and 2 equal to the ſmall ſides of the triangle.

Without recourſe to calculations, when ſuperfluous, it is evident by the figure, that the fronts which can be diſpoſed againſt the gorge of the baſtion, are not near double in length to the ſum of the others; if we compare the arcs of the circle, we ſhall find that 1 is more than 133 fathoms, and the other about 206. Laſtly, the radii of theſe arcs, that is, the diſtance from the point from whence I ſuppoſe the fire to come to the middle of the gorge, will be between 71 and 72 fathoms in the redan, and 91 in the baſtion; another diſadvantage in this laſt conſtruction.

The obſervation muſt then be juſt, if we come to cloſe with the enemy, it is eaſy to force them from the redan, being drawn up in form of a reverſed coin; the gorge of the baſtion is but 77 fathoms, and the total of the fronts, which batter it at right angles, is more than 184; therefore there is no equality between the aſſailants and defendants; though I agree to this inconvenience, I doubt if the engineer who diſcovered it, thought it conſiderable enough to reject a method, otherwiſe ſo advantageous.

III. In 1743, neceſſity obliged me to invent a kind of lines which I think uſeful in certain caſes, viz. when we are to turn a ſmall river, or can fill the ditch with water. It was at the camp under *Landau*. *Marechal de Noailles* ordered me, when I was leaſt prepared for it, to trace an intrenchment from the mill of *Oſſembach* to below the village of *Offerſheim*; it was near 2400 fathoms: this work was ordered to be begun by break of day, it was then almoſt night, and I half a league from the place. I did not know where to find piquets,

nor

nor any one to help me, and the workmen were to begin at break of day: if, according to the ſaying of a great man, that the word *impoſſible* ſhould be left out of the dictionary, it ſhould be eraſed out of the *ſoldiers dictionary*; it is a mortifying word to uſe: the thing did not yet appear practicable to me. I therefore propoſed to trace it in a right line, with ſome ſaliant angles at a diſtance from each other, intending to flank it by ſome detached works, when more at leiſure.

An engineer has reaſon to be ſatisfied with his orders, when the general who gives them is himſelf an engineer, and does not diſdain to enter with him into the moſt minute detail. I pointed out the impoſſibility, which he was not ignorant of, and the expedient which had ſtruck me; he readily conceived the advantage of having a parapet and a river before one, when we have not a moment to loſe in intrenching ourſelves, and that the works with flanks that I propoſed, furniſhed 4 columns of fire, inſtead of 2, and being ſeparated from the intrenchment by a ditch full of water, if the enemy took it they were not much more advanced, ſince they could not keep there; that nothing was more advantageous, than to have artillery placed in ſuch works as projected beyond the line. Plate XXII. Fig. 2.

The day was quite ſpent when I arrived at the place, and the fires I had lighted to ſhew the line were confounded with thoſe of the camp, and to add to my misfortunes I had a fever: I was therefore ſoon obliged to give over; but at 9 next day the line was traced: and being worſe than the preceding day, I had great occaſion for ſo good an aſſiſtant as *M. de St. Paul*, and was alſo much obliged to *Le Chevalier de Beauſobre*, at preſent colonel of the *Huſſars*.

This work begun the ſame day, was finiſhed before I had traced the detached pieces, being otherwiſe employed: and as it was thought that nothing more was to be done than what appeared, this long line without flanks was ridiculed with ſome appearance of reaſon;

and

and the motion of prince *Charles* of *Lorrain*, having obliged us in the mean time to ſend a conſiderable detachment towards the higher *Rhine*, and to retire with the reſt of our troops behind the *Moutre*, I doubt if this piece of work gained me any credit with moſt officers of the army.

We find the baſtion here have not the inconveniency I have ſpoken of in the preceding article (for theſe lunettes with flanks are in effect detached baſtions) ſince the enemy cannot keep there till he has done, that is, till he has forced the line: but this method is not good, when the ditch is not full of water.

IV. I practiſed another occaſional method of fortifying, much more expeditious, at the ſame camp, from *Quiechem* to the mill of *Offembach*.

This method has the advantage of the other, being practicable in dry or wet ground, it conſiſts in covering the front of the line with detached works, turned ſo as reciprocally to defend each other, or thoſe which may afterwards be added in their intervals.

When we are likely to be diſtreſſed for time or workmen, the diſtance from the middle of one of theſe works to that of the next may be 240 fathoms. If attacked in this ſtate, the enemy cannot break thro' the intervals, without firſt taking theſe pieces, or being flanked.

If time permits, the intermediate pieces are conſtructed, and the line is then defended in the ſame manner as the fore-mentioned ſcheme for *Pilſting*, or what was practiſed in the plain of *Deckendorf*. We may alſo obſerve, that in this caſe we are exempt from one of the great defects of lines in general, which is, that we cannot ſally from them but by a ſmall front: but as it is neceſſary, eſpecially when inferior in number, to guard theſe great intervals, nothing prevents our cloſing the whole afterwards, by ſtraight or broken curtains.

Great care muſt be taken in tracing theſe lines, piece by piece, leſt we ſhould batter the work which is to follow, inſtead of flanking it.

V. Thoſe lines which are formed of detached works, tho' they may be eſteemed as of this kind, are traced in a very different manner. Such were thoſe according to the hiſtory of *M. de Turenne*, which were raiſed by General *Merci* in 1645, for the battle of *Nordlingue*; each piece was compoſed of a redan, placed in the middle of two common demi-curtains, whoſe extremities were terminated by a hook.

As I only quote this from the plate, which had no ſcale, I do not know what were the proportions; but changing the figure a little, I would recommend the following conſtruction.

Draw lines 100 fathoms long, and 100 fathoms from each other. At the middle of each line trace a redan of 30 fathoms gorge and 24 capital. At the extremities of theſe lines erect perpendiculars of 20 fathoms, for the brake of the branches: from the foot of the perpendicular to the ſummit of that of the next front, draw the line of defence, on which lay 6 fathoms for the direction of the hook. Plate XXIII. Fig. 2.

Theſe intervals are covered by 4 columns of croſſed fire, on which account I make them no larger: the greateſt part of the branches have 3, without reckoning the direct fire, and the faces of the redans are flanked nearly at right angles by the whole length of the branches; advantages which the intrenchments of general *Merci* had not, as the demi-curtain formed a right line.

As to cannon, they may be placed in the angles of the redans, or if we chuſe only to uſe ſmall arms in theſe works we may place them in the intervals, as general *Merci* did.

Intrenchments, detached in parts, may be fortified various ways. All are good, in proportion as the intervals

intervals are, and each particular part, more or leſs defended.

VI. This ſubject naturally leads me, to ſpeak of another kind of fortification, which does not differ much from this, tho' we cannot properly give it the name of lines. Except the laſt, whoſe uſe is more doubtful, all the lines treated of, either ſuppoſe, that we ſeek to avoid an action, or are not willing to loſe the advantages gained by them; but their uſes in regard to battles, are not confined to the defenſive alone.

When a general, more than equal in forces, or reſolved to riſk an engagement, advances to a camp which he has reconnoitred, to ſtop an enemy; or by drawing nearer to them, will oblige them by his poſition to attack him; will not attempt to intrench his camp at the moment almoſt of the action, and to begin works which probably he would not have time to finiſh; he would not beſides encloſe himſelf, and put it equally out of his power to attack, purſue, and reap all the advantages of a victory; but will ſeek to ſecure himſelf by thoſe precautions which oft decide it; precautions eaſy, of little work, and which no ways obſtruct the neceſſary motions.

Theſe precautions generally conſiſt, eſpecially if weak, in cavalry, or the wings not ſufficiently ſupported, in ſecuring the flanks by felling, or *Chevaux de Friſe*, in deepening ditches with upright banks, in ruining bridges, in deſtroying fords, and by rendering them every where as inacceſſible as poſſible.

When there are villages, or ſome great building towards their extremities, they muſt immediately be put into a ſtate of defence; the ſame uſe is made of them which are but at a ſmall diſtance before the line, eſteeming them as fixed points and flanks. If we have leiſure, large redouts are conſtructed, if not on all the front, and ſo as their fires may croſs, at leaſt in the weakeſt places, or from whence the artillery can be moſt advantageouſly ſerved.

It is uſeleſs to add more, as all depends on circumſtances, nothing poſitive can be ſaid; and ſpeaking in general would only be unneceſſarily repeating what I have ſaid in 7th article of 4th chapter.

VII. I cannot give an example of theſe precautions, more known, or convincing, than that of the battle of *Fontenoy:* but as it is foreign to my ſubject to give a detail of the engagement, I ſhall confine myſelf to what concerns it, by the wiſe diſpoſitions of a general, who all *Europe* confeſſes, juſtified in the beginning of that war, what a celebrated writer had predicted of him. (*a*) Plate XXIV.

The right of our army being ſupported by *Antoin*, and conſequently by the inundation of the *Scheld*, it was neceſſary for greater ſecurity to intrench the village, which was done in the night, by the troops that guarded it.

From *Antoin* to *Fontenoy*, another village intrenched with great care, and which was the centre, is 800 fathoms. This front was covered by 3 redouts, the firſt on the ſide of *Fontenoy*, the 2d 100 fathoms from the firſt, and the 3d 140 fathoms from the 2d, they were conſtructed, or rather roughly thrown up, the ſame night. The want of time, apparently hindering their increaſe, the fortification of the centre was principally attended to, which was the moſt eſſential, becauſe the reſt was flanked by the village of *Antoin*, which commanded almoſt all the breadth.

The left, ſquaring with the front, extended to the woods of *Barri*, joining to the village of *Ramecroix*; we had felled the wood at that place, and poſted the regiment of *Graſſin* in it, to obſerve what paſſed there.

(*a*) *Folard*, ſpeaking of the method of firing which *Saxe* had introduced into his regiment, "A method (ſays he) that I admire, as "much as its inventor, whoſe genius is one of the greateſt I know." Book II. Chapter 14th.

It is plain we did not find this wing ſo eaſy to ſupport as the right; but the wood, crowded as it was with infantry, the felling which, covered the edge and two redouts, which were raiſed there, ſupplied this ſo well, that the brigades which formed it, ſerved in the heat of the action as a reſerve to the centre.

It requires no other proof of the neceſſity of theſe works, than the obſtinate bravery, with which the *Engliſh* attempted to force *Fontenoy*, deſpairing to break thro' elſewhere. This poſt, by the beſt accounts I have ſeen of the action, was a capital point, and of greater conſequence to us to defend it, leaſt the enemy, once maſters of it, would have maintained themſelves in it, and have cut our army in 2.

I have nothing more to add on this battle, but the ſteadineſs of our troops; for works ſo imperfect, could not be ſupported againſt ſo vigorous an attack, without great reſolution. Yet all the fire of the village and the redouts, could not prevent the enemy from penetrating between both; a bold courageous attempt, and which ſeemed once to have given them the victory, but which at length, by a prudent motion on our ſide, was turned in favour of us. (*a*)

Obſtinate indeed! FONTENOY BATTLE, 30 *April*, 1744, with only 20,000 *Britiſh* in an open country, to attac 120,000 *French*, with their King, Dauphin, and *Saxe*, one of the moſt celebrated heroes of his time; intrenched with maſked batteries. Wood covered with redouts, and felled trees, villages covered by batteries and parapets, &c. with all theſe advantages the DUKE of CUMBERLAND had victory on his ſide great part of the day, and had it not been for the timid *Dutch*, he had obtained the moſt glorious victory on record, conſidering the odds of their ſituation as 20 to 1, cannon 20 to 1, men 5 to 1, &c.

(*a*) From Capt. *Eimes*'s Military Guide.

Voltaire

Voltaire ſaid, that *Saxe* ſent three times to ſecure a retreat, and to the King and Dauphin to fly, every moment apprehending a total defeat, had the baſhful Dutch done their duty, the moſt amazing victory had been gained; here every *Britiſh* ſoldier behaved like a *Cæſar*, a day of immortal honour to the Duke. It may be truly ſaid the conquered retired with the laurels.

VIII. The importance of theſe articles, and their connection with the preceding, will favour the digreſſion in the laſt: but to return to our ſubject.

It has for ſome time paſt been ſtrongly debated, whether or not it be proper to join works cloſed at their gorge to lines: it was formerly practiſed, at leaſt we may judge ſo by thoſe of circumvallation and countervallation. Moſt treatiſes of fortification prove this, and not only redouts, but ſtars, ſquares with half baſtions, and other conſiderable works.

The *Imperialiſts* ſeem yet to uſe them, for we found them in 1734 at the lines of *Etelingue*; as for us, we have abandoned them; the laſt time we uſed them was I believe at the lines of the *Loutre* in 1706, where we erected ſome redouts in the moſt expoſed places, and chiefly to defend the dams, and to place batteries in.

At the ſame time perhaps we abandoned the epaulments for the cavalry, whoſe uſe we ſhall treat of hereafter; it is not only neceſſary to know what is, but what ſhould be practiſed; that is, whether we have greater reaſon to ſuppreſs the one, or neglect the other; it is ſometimes with theſe, as with faſhions, which many follow without reflection, and ſome rather than be ſingular.

M. Vauban, in his memoirs on the conduct of ſieges, ſays, theſe works were no more conſtructed, becauſe they were found dangerous; but the only reaſon he alledges in his *Treatiſe of the attack of places*, wrote many years after, is that of the brevity of ſieges; thus he does not determine definitively, beſides he only ſpeaks of the circumvallation.

I ſhall

I ſhall not attempt to decide this point; what I ſhall ſay, muſt only be regarded as one ſingle opinion, which I am obliged to venture by the nature of my ſubject.

Plate XXXII. Fig. 1. This method, well managed, may certainly be uſeful in many reſpects. Theſe pieces elevated more than the reſt, placed to advantage, by their protection and command of ground, might defend the adjacent parts; they are aſylums at ſmall diſtances, under whoſe fire the troops drove back, or broke, may take breath and rally; it is alſo common in a briſk attack well ſupported, to be forced to abandon a battery, which when regained, and it is not without example, the enemy will have nailed up the cannon or have been very careleſs; by this we are leſs expoſed to ſuch inconveniencies.

According to the *Marquis Santa Cruz* (*a*) we gain another advantage. He would have us regard an intrenchment, as divided into 4 parts, and each part given to the command of a general, who ſhould march with his troops, to form in the place deſigned, if the enemy attacks on that ſide; and they cannot form with more order and tranquility than under one of theſe pieces.

Thus we have ſhewn their advantages; on the contrary, if the enemy once enter theſe works, the loſs of the lines is almoſt certain, by the difficulty of diſlodging them.

If this is the only inconvenience, as I believe it is, we may eaſily remedy it. Theſe works are of evident uſe, they muſt then be made; we have every thing to fear if the enemy once take them, they muſt then be conſtructed with ſo much care, as to hinder their acceſs, and not expoſe ourſelves to ſuch danger.

When I ſay they muſt be made, we ſhould underſtand, that it is not indiſtinctly on every occaſion, but only when we have time to put them into ſuch a ſtate, as not to be carried by aſſault, and principally in lines

(*a*) On encampments, chap. 7. ſect. 2.

con-

conſtructed at leiſure, and deſigned to laſt a long time.

All kinds of works are not proper in this caſe; we muſt avoid thoſe which batter any part of the intrenchment; for in an alarm in the night, and oft in the day, the ſoldiers bordering the parapet, fire confuſedly on all ſides. The ſtar, a dangerous piece, if within reach of another, ſhould for example be avoided. The chief care is to perfect the works, and cover the ſpace between as much as poſſible.

Observations on the eighth Chapter.

The manner of conſtructing lines and retrenchments is here continued; but, as in the former chapter, thoſe made with redans, or with ſaliant and rentring angles, have been chiefly conſidered; here they are made with baſtions, as may be ſeen plate 21. The firſt figure repreſents one conſtructed in the uſual manner; but as the ditch is but narrow, and its counterſcarp parallel to the parapet, a part near the ſhoulders of the baſtions cannot be ſeen from the oppoſite flanks; for which reaſon it ſhould be ſloped; and if a greater defence be deſired at the ſaliant angle, the ditch may be widened from thence towards the ſhoulder. But as the conſtruction of baſtions requires too much time and labour, it is not always convenient, nor neceſſary, to make them all round; beſides, all parts are not equally expoſed, and therefore the weakeſt ſhould be ſtrengthened by ſuch works, as to render their approaches as dangerous as that of the reſt. This was done at the ſiege of *Philipſbourg* in 1734, where the line of circumvallation was partly conſtructed with baſtions, and partly with redans: the part moſt expoſed had alſo a horn-work added before the curtain; and others had double ditches, with pits full of ſtakes between them; laſtly, the part near the woods was ſtrengthened with fell trees.

As the ſituation of no camp whatever is on all ſides the ſame, but has either a river, moraſs, or riſing

ground before it; it is the engineer's duty to uſe all the advantages of art and nature.

The author obſerves, that as the ſtrait curtains have no other defence than directed before them, and the greater defence of the front is directly towards the part leaſt liable to attacks, he gives an example in the 2d figure, with broken curtains; as hereby a 2d flank is added to the defence of the baſtions, and the fire more ſpread and better divided. It may be obſerved, that when ravelins are placed before the curtains, this 2d defence becomes uſeleſs, and in that caſe I prefer the ſtrait curtain before the broken.

The author ſtarts an objection againſt lines with baſtions, more curious than uſeful, ſo far as relates to the real defence: but faults, though in appearance, ſhould be examined, to prevent miſtakes. I ſhall endeavour to remove all the author's ſuſpicions; he ſays, when an enemy has once got poſſeſſion of the baſtion, and is not ſtrong enough to advance, it will be attended with greater difficulty to drive him out than out of a redan: this he endeavours to prove by the 2 firſt figures in plate 22; where he obſerves, that a greater number of troops may be placed before the redan, in proportion to the enemy it can contain, than before the baſtion; but the author forgot that the baſtions are well defended by a grazing fire, and that ſingle redans have no defence; beſides, as the baſtions are more ſpacious, there is more room for placing troops in them to defend the enemy's approach, and conſequently the attac of a baſtion is infinitely more dangerous than that of a redan. Let us ſuppoſe, that the enemy has got poſſeſſion of one or the other, will there not be a ſufficient number to drive them out? They cannot be ſuccoured in the baſtion without ſuffering a furious diſcharge of artillery and ſmall arms from the oppoſite flanks; unleſs the defenders give all over for loſt, and run, they will have it always in their power to drive them out of the baſtion,

tion, and that with more ſlaughter than out of the redan.

The 2d figure plate 22, repreſents an intrenchment, intended to have been made cloſe to a river; and as it was to be executed directly, time would not permit to make it of any other figure than a right line; but detached baſtions and lunettes were to be added afterwards, ſuch as are marked here, whereby the author imagined it would have a good defence; becauſe, if the enemy ſhould get poſſeſſion of any of theſe detached works, he would be ſtopped by the wet ditch, and ſoon be drove out by the galling fire from the oppoſite part of the line. Yet as the faces of the detached baſtions are not defended from any other part, this conſtruction is defective on that account; whereas, if the outworks were conſtructed in ſuch a manner as to defend each other, they would then be able to make all the defence that could be expected. How the author did not perceive this defect, ſo contary to his eſtabliſhed principles, is impoſſible to define.

When the approach of an enemy is ſo ſudden, as to leave no time for finiſhing the retrenchment, detached baſtions and lunettes ſhould be made at proper diſtances, ſo as to flank each other, and the curtains muſt be ſupplied by fellings of trees, wheel-carriages, or ſtakes, timber, &c. and if there is time, the curtains may then be made. If a general is willing to riſk a battle, artillery and muſketry muſt be placed in theſe detached works, and the intervals left open for him to march out in order of battle when he thinks proper: if the enemy is determined to puſh thro' theſe openings, the fire of the artillery and ſmall arms, coming from theſe works, may perhaps make him repent of his raſh attempt, or at leaſt diſorder him in ſuch a manner, that if the troops march in good order againſt him, it will be no difficult matter to defeat him.

The firſt figure plate 23, repreſents an example of this kind, with this difference only, that the ad-

vanced works do not flank each other but very imperfectly, ſo much the more ſurprizing, as the author inſiſts ſo much upon it, in moſt of the former parts of this work: whether he imagines theſe flat baſtions to be more commodious, or that the enemy will rather chuſe to paſs between than attac them, I know not; but in my opinion he will not paſs by them, without deſtroying their faces, and on taking them, which he may eaſily do, ſince there is nothing that can prevent him, if he has artillery, and without which no army now marches; on the contrary, it is what the ſucceſs of all actions chiefly depends upon.

The 2d fig. plate 23, repreſents another kind of detached works, which requires more labour and time than the former: the parts defend each other much better; but I think the end of the one does not ſo well defend the end of the other, as if their defence was juſt to graze the oppoſite angle: ſuch examples are always uſeful, as they inlarge the number of different forms in which lines may be made, and ſometimes one form, at others another, may be uſed, as the nature of the ground will permit, and all of them be uſeful on different occaſions.

After all the various conſtructions of lines that the author could think of, he ſays, it has been a queſtion for ſome time, whether it was proper or not to join works incloſed on every ſide, to lines or retrenchments; that is, redouts or forts. Some are of opinion, by placing them at proper diſtances, that when an enemy has entered the lines in ſome parts, the troops in the adjoining parts of the line may rally and form under the protection of their fire; and that they ſerve as ſo many points fixed, where the troops are to join, in caſe the enemy ſhould penetrate the line in any place. On the contrary others maintain, that ſuch works are dangerous, that if the enemy ſhould get poſſeſſion of any, it would be very difficult or almoſt impoſſible to drive him out. In all queſtions of this kind, the general

neral manner in which they are propoſed renders them ſeemingly more difficult to ſolve, than they otherwiſe ſhould be; for if a particular work is not proper upon one occaſion, is there any reaſon for its not being ſo on any other? It would be more advantageous to the reader, to find out where and when a work of a particular kind may be uſeful: for there is none but may be good on ſome occaſions. Thus when an advanced fort can be turned, or one near the ſea or a river can be attacked in the rear, it is evident that it ſhould be fortified all round; how many batteries and forts have been taken, for want of this precaution. As to forts in or without lines, if it is difficult to drive an enemy out of them, it muſt alſo be as difficult for an enemy to get poſſeſſion of them. The query lies then, whether ſuch works may not be made ſo ſtrong, as that the taking of them would coſt more men, than the poſſeſſion is worth; that this can be done there is no doubt; therefore when a general judges ſuch works neceſſary, he ſhould ſee it made, ſo as to anſwer his deſign; if time will not allow it, he would be to blame to hazard his troops. Upon ſuch occaſions, the judgment of a general, and the ſkill of an engineer, muſt decide what can be done, to ſecure his army from the danger of being defeated.

CHAPTER THE NINTH.

I. *Advantages from a river, to cover lines.* II. *What may be done in flat ground, when under the fire of the intrenchment.* III. *When it is at a diſtance from the whole, or any part.* IV. *Inundations; where they may be made by ſingle dams.* V. *Thoſe made with ſluices; their inconveniencies.* VI. *A more perfect ſcheme.* VII. *Scheme for an inundation for lines that are to ſtand a long time.* VIII. *Multiplicity of dams; means of correcting them.* IX. *Dams too long; means of defending them.* X. *Recapitulation of all theſe defects.* XI. *A new method of forming inundations in flat ground, in any place.*

I. OF all that can be expected from the natural ſituation of the ground for the defence of intrenchments of great extent, ſuch as lines, there is not any more advantageous than a body of water, which is, or can be made, ſo deep as not to be forded.

This deſireable aſſiſtance would naturally preſent itſelf, without any neceſſity of improving it, whenever there is a large river in front, was it not for one circumſtance, namely, that it could not be turned by the enemy.

It is rare to find theſe advantages united: the courſe of a river, ſuch as we here ſuppoſe, is always of ſo great extent, that it is impoſſible to line one of its ſides entirely; whatever may be the ſituation, or extent, the intrenchment will not hinder an enemy from paſſing above, or below it.

Theſe rivers, ſpeaking in general, cannot ſerve for this uſe, but may become themſelves almoſt an impenetrable barrier, by the help of much leſs, and quite different works, which we ſhall treat of in chap. 10.

Moſt ſmall rivers are preferable in this caſe to large, for they commonly riſe in the mountains, and running through

through a flat ground for ſome leagues, empty into others.

The great river and the mountain, in this caſe, ſerve to cloſe and ſupport the extremities of the line; there is no more required, than to render the front difficult of acceſs, by the aſſiſtance of the ſmall; which is executed after different forms, according to time, places, &c.

II. We have already obſerved, that when a riſing ground or eminence runs parallel to the river, the line muſt be traced on it, as well to have a command, as that the camp may be more dry and wholeſome, and the communications be on firmer ground, the better for carriages.

When the line thus traced is every where at a proper diſtance from the river, that is, from 80 to 100 fathoms, it is a great advantage, becauſe the paſſage is defended by ſmall arms, without much labour.

If the meadows between are level and of a great breadth, ſo that they cannot retain the waters, or if time or means is wanted to undertake a greater work, it will be ſufficient to raiſe them within their own banks, and keep up the water at certain ſpaces that it may not be forded: there are few that have not banks 5 or 6 feet deep, and that is ſufficient; if they are ſteep, they are a greater obſtacle to the enemy.

Theſe waters are generally ſupported by dams of earth, which being raiſed above the banks, force the water over the meadows; theſe works, the only I have ſeen, have a great inconvenience, as they ſerve for bridges to the enemy. Thoſe I invented at *Deckendorf*, and uſed in 1743 at the camp of *Queich*, are exempt from this defect.

Their number depends on the great or ſmall fall of the river, and the height of its banks from the water; for example:

If this fall is 2 feet in 100 fathoms, and the depth of the bank only 5 feet; the dams muſt of courſe be

repeated at every 25 fathoms, to make the water riſe 4 ½ feet, which is the proper height to prevent its being forded.

If this fall be only 6 inches, and the banks 7 feet, a dam at 500 fathoms diſtance will produce the ſame effect.

III. In the preceding article, I have ſuppoſed the whole courſe of the river under the fire of the line; a very advantageous circumſtance, becauſe the enemy may be prevented from throwing bridges over it, or cutting the dams; yet when the river runs above 100 fathoms from it, which I reckon a very proper diſtance for ſmall arms; by additional works, as much or more aſſiſtance may be drawn from it.

Plate XXV. Fig. 1. If it runs off in elbows, which are neither too open, or too much ſunk, ſome advanced works, joined to the intrenchment by good communications, will ſufficiently protect them.

Plate XXV. Fig. 2. If the depth or breadth of theſe curves render that expedient ſubject to difficulties, a canal muſt be cut from one extremity of the curve to the other, in a ſtrait line, obſerving to dam the old bed, as in plate 25, leſt the eneny ſhould turn off the water.

When the river is every where at too great a diſtance, a new bed muſt be dug for it, to draw other advantages beſides thoſe which the nature of the ſituation affords.

The direction of this new bed requires ſome eſſential obſervations: if the eminence, on which the intrenchment is ſuppoſed to be, is too high to carry the water up, or the ſide next the meadow very ſteep, the canal may be cut from 15 to 20 fathoms diſtant, or more, if that is not ſufficient to command it throughout, throwing the earth on both ſides, in form of a glacis, which increaſes the depth. I ſay from 15 to 20 fathoms, as that diſtance does not diminiſh the effect of ſmall arms, and a ſoldier, eſpecially if he is not well diſciplined, will be

be leſs confuſed, and fire more exact, than if the enemy was nearer.

Where the hill is ſteep, the line ſhould lie as cloſe to the hedge as poſſible, and the ſide ſcarped, to render it difficult to mount the intrenchment; and where it is neceſſary to run off from the ſide, it muſt be made in form of a glacis, ſo as to leave no cover before it, which alſo furniſhes earth for its conſtruction; at leaſt in the firſt caſe, without being under a neceſſity of digging a ditch, which being very low in regard to the ſummit of the parapet, will be badly defended.

In the other caſe, that is, if the intrenchment ſlopes gently down to the meadows, and the river can be brought there, nothing better can be done than to turn it into the ditch; which is then indiſpenſible, as well to defend the acceſs to the parapet, as to get the earth of which it muſt be made.

The river, which muſt be dam'd at the place it quits, and where it falls again into its old courſe, being at leaſt ſufficient for a reſervoir to ſupply theſe 2 different canals with water, will alſo ſerve as a double barrier to the intrenchment.

IV. When the river flows without much rapidity, in a valley, bordered by riſings, or when the ground riſes gradually to the right and left of the river, all before it may be laid under water.

Theſe inundations are made by dams of earth, which barring the river and the loweſt part of the ground, retain and elevate the water; but as the water may carry away the dam if it ſhould overflow, care muſt be taken to make proper voiders.

Experience ſhews, that ſhallow water flowing on natural ground, does not hollow it, when it can extend itſelf. In conſequence of this obſervation, whenever the valley ſlopes towards the river, there is no occaſion for any other diſcharger than the ground itſelf beyond the dam; but for greater ſecurity the ends muſt be hurdled and gazon'd.

Ano-

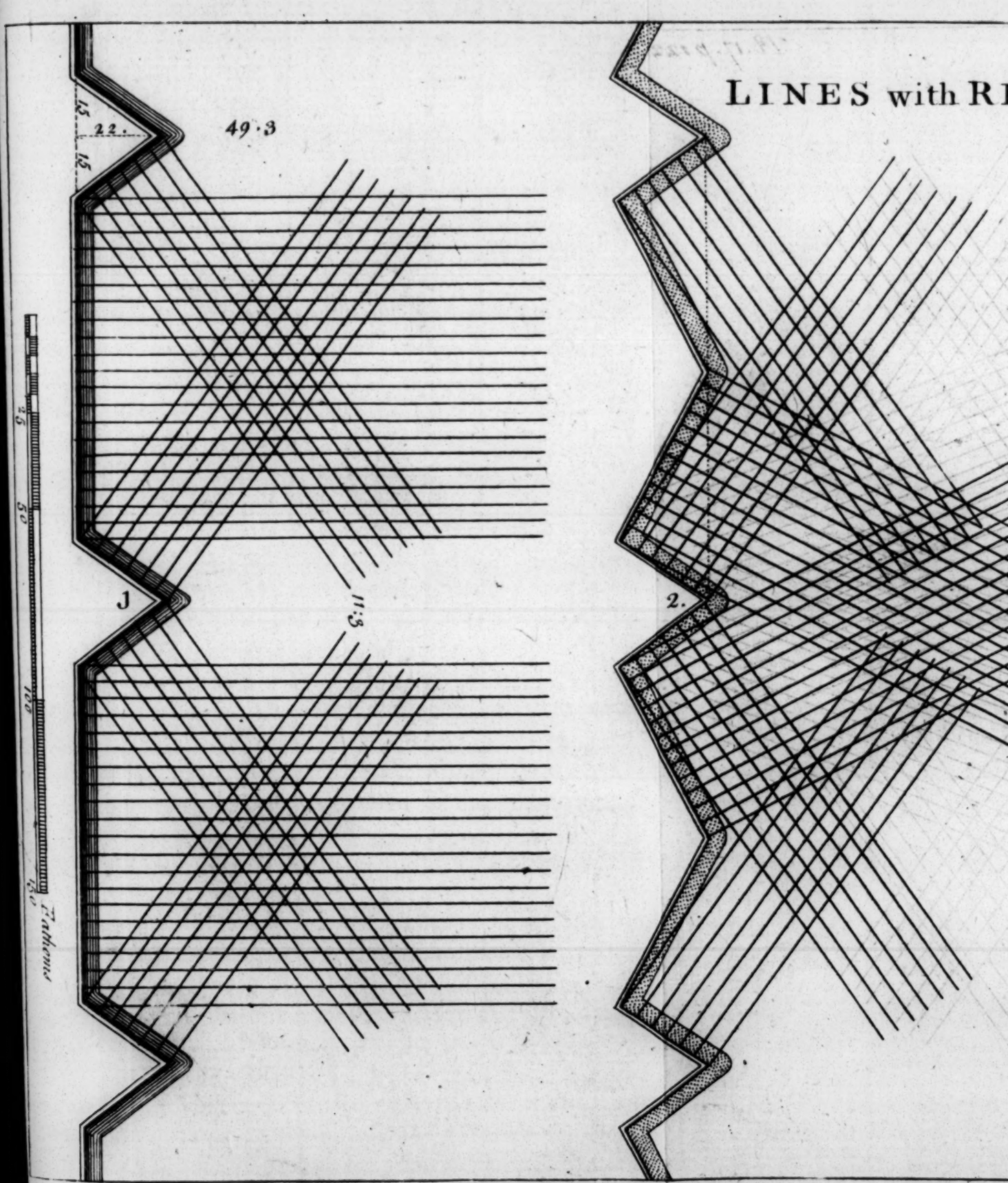
Another material advantage reſults from this work: whether the enemy cut the dam, or turns off the water by a canal, they can only drain one part of it; becauſe to drain it entirely, they muſt dig and advance, as it runs off to the very loweſt part; which is not to be done in one night, affords time to diſcover and oppoſe them; beſides, they cannot do it without being greatly expoſed to the fire of the intrenchment.

V. Theſe natural diſcharges ſave much work, and do not require great care in uſing them; but only to be uſed in ſuch places as I have mentioned. Yet where the valley is level, or ſo narrow that the ends of the dams muſt be carried to the riſing grounds, or even from one hill to another, it is evident, recourſe muſt be had to other means. In that caſe ſluices of wood are conſtructed, and placed according to the uſe they are deſigned for.

When they ſerve as diſcharges only, they are erected on the meadow, and the flooring fixed on the level of the ground. The advantage reſulting from this is, that there is no excavation required but for the foundation, and theſe ſluices being leſs high by the depth of the river, require leſs time and wood for their conſtruction; they are alſo eaſier managed. Theſe advantages are counter-balanced by different inconveniencies; the river not being able to paſs over the flooring, cannot have its natural courſe, without cutting the dams that ſtops it; which is neceſſary to be done, when the enemy is at a diſtance, or at the end of a war, to drain the inundation.

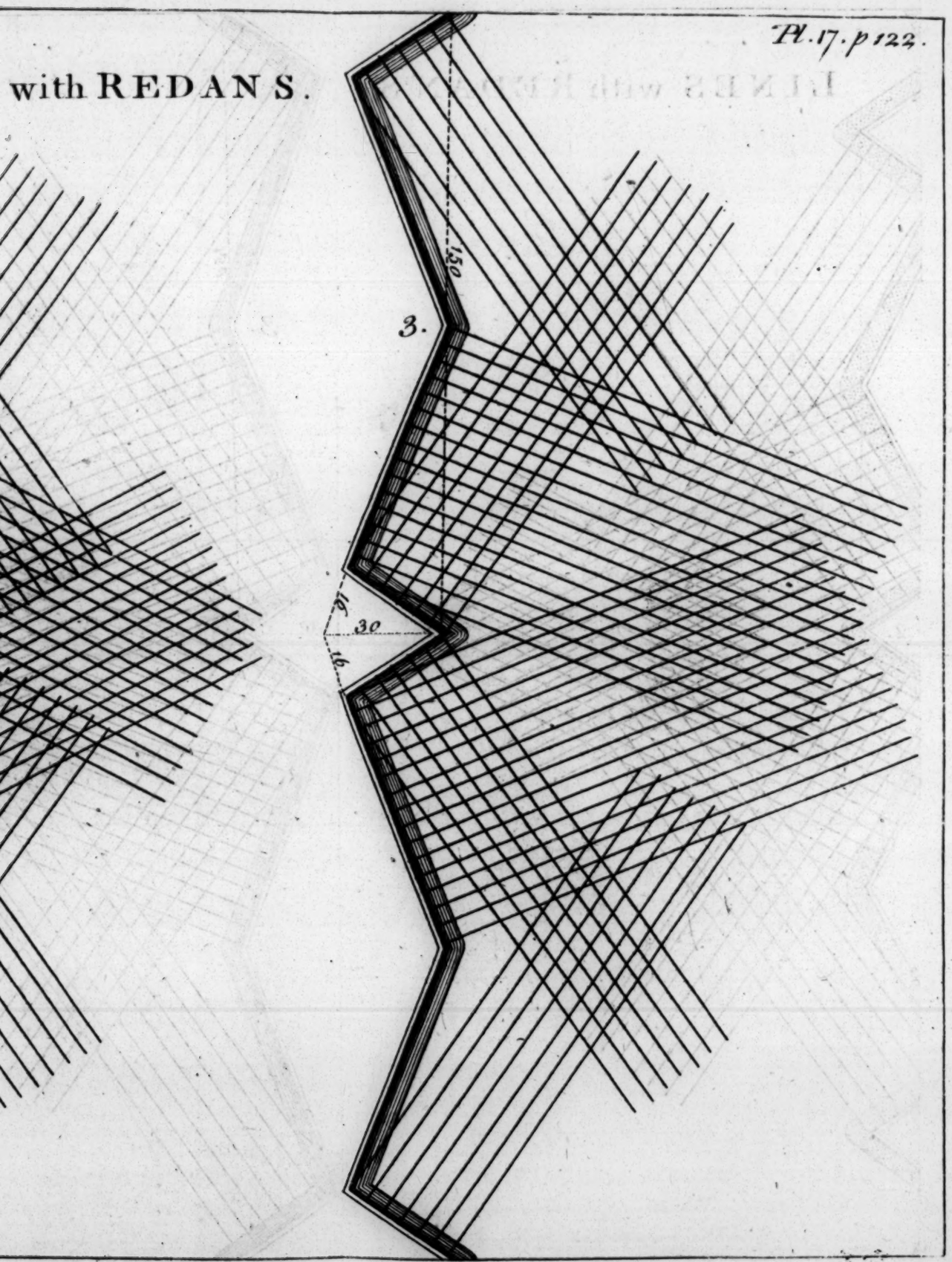
Theſe diſcharges require continual attention; for the baſons once full, the vanns muſt be raiſed to a certain height to let a quantity of water paſs, exactly equal to what enters; I ſay exactly equal, for if they are raiſed too high, the inundation falls, and if the oppoſite extreme, it may perhaps blow the ſluice and carry off the dam.

A few


LINES with R
15
22.
15
49·3
11·3
J
2.
25
50
100
150
Fathoms

Pl. 17. p 122.

with REDANS.



A few hours rain, or a ſudden thaw of ſnow, conſiderably ſwells theſe mountain rivers; they muſt therefore be watched night and day. A cannon ſhot, or ſome defect in the wood, or their conſtruction, may diſorder the whole in a moment.

VI. The count *d'Aumale* having ordered me during the campaign in 1743, to put the lines of the *Loutre* in condition; theſe conſiderations obliged me to ſeek ſome method more ſimple, ſure, and leſs fatiguing, to diſengage from the ſuperfluous water ſome new dams I wanted to raiſe, and repair moſt of the old; my deſign was to dam thoſe ſluices moſt expoſed to cannon; and thoſe that are made ſo low as the bottom of the river, ſupport a great height of water; which renders them leſs ſecure and more difficult to manage.

I determined to uſe reſervoirs of wood, the flooring laid on the interior ſide, 3 or 4 feet lower than the ſummit of the dam, had according to this ſcheme a convenient ſlope. 5 poſts with grooves divided the entrance into 4 equal parts or paſſages, making together 24 feet opening, which is double the common breadth of theſe ſluices, and may perhaps appear exceſſive, if I did not aſſign my reaſons.

Water paſſing thro' a ſpace double in breadth to another, runs about half as high, which renders the inequality of the body leſs ſenſible; it is therefore much eaſier to keep the inundation at a certain height by means of theſe ſhutters.

Beſides, if 1 of the upper ſluices is carried off, or 1 of the dams ſhould burſt, all is in danger, if the diſcharges are not large enough to give ſufficient room for this additional water to ruſh out. It is for that reaſon I make the floors of the reſervoirs ſo low; for in ſuch an emergency all the ſhutters muſt be raiſed, though it does not appear neceſſary; for the upper waters continually encreaſing the breach they have made, come down ſuddenly in greater abundance.

Theſe reſervoirs ſhould be made at a little diſtance from the line on the meadow, and not in the river, becauſe the depth would render them leſs ſolid. As they have leſs wood-work uncovered, and as the ſhutters ſupply the place of vanns, they are more ſecure from cannon than ſluices, to which I think them preferable, as well for the above reaſon, as being of a much lighter and ſimpler conſtruction, there is no more time required for them, than what the ſoldiers, or pioneers employ to raiſe the dam, ſo that all is finiſhed at once.

VII. When the lines are made to ſubſiſt all the war, or even in peace, one would chuſe that theſe inundations may be made and filled on the firſt order, viz. in the ſhort time neceſſary for filling or emptying their baſons, ſome little additional work muſt be done.

Each dam muſt in this caſe have a ſluice, the cill of which muſt be as low as the bottom of the river, and the floor large enough to let the water paſs at all times, the courſe of the water not being conſtrained, the dams never need be cut to let out the water on any emergency, when they are ſettled and well ſodded; ſuch as we need not fear. This is the only uſe I think we ſhould make of theſe ſluices, as well for the reaſons already given, as the following.

Firſt, Their height being equal to the depth of the river, it is oft very difficult, and ſometimes impoſſible to raiſe or lower the vanns, in a great depth of water; for theſe vanns being very high, are greatly preſſed againſt their grooves, tho' ſupported by the lower inundation. I here ſuppoſe the common vanns, becauſe they are ſubject to leſs inconvenience, than thoſe of a more complicated conſtruction.

2*dly*, The ſuperficies of the inundation muſt be regulated by the ſhutters, and the river muſt fall entirely in a caſcade. It is eaſily conceived what the floor muſt ſuffer, by the continual preſſure of ſuch a body of water, as well by its weight, as its whirling, and the mud which will be gathered there.

3*dly*,

3*dly*, Theſe ſluices are commonly founded in clay; but as liquids preſs in proportion to their depth, the leaſt filtration between the earth and floor, increaſing every moment, may blow it up. The cill indeed is more ſecure, becauſe of the dovetailed piles, which ſhould be drove before and behind it.

Theſe ſluices ſerving only to retain and drain off the water, and not to keep it at a determined height, have no occaſion for vanns. Two rows of piles, diſtanced from each other in proportion to their height, ſerve for, and form with the checks, a coffer, which is filled with earth well rammed, or with clay. This batardeau ſecures the front piles, which it ſupports, and the floor which it bears on; we have thus nothing to fear from cannon. As to the ſuperfluous water, it is diſcharged by ſuch a reſervoir as I have mentioned.

VIII. Having thus ſhewn my opinion on the different methods of covering lines by inundations, I ſhall here remark the principal difficulties attending, and the means I would recommend to ſurmount or avoid them. The conſtruction of dams is ſubject to 2 inconveniencies; their multiplicity cauſed by the great fall of the ground, ſhall be the ſubject of this article.

Theſe dams made of earth (for thoſe I promiſed the conſtruction of, will be uſeleſs here) are, as I have already remarked, as many bridges for an enemy, and conſequently an annoyance and fatigue to an army to guard them. The only remedy I know for ſo eſſential a defect, is to make them only at all thoſe places, which are deſigned for poſts; as this decreaſes their number, and to make them as high as poſſible with prudence, if there are ſluices in the river, there will be found an advantage, which perhaps does not preſent itſelf at firſt view.

Suppoſe the river 5 feet deep; if the cheeks of the ſluice are only raiſed 9 feet, it is evident they will throw but 4 feet water on the meadow. If there are 4 ſluices following each other, and diſtanced ſo that each

ſupports

ſupports theſe 4 feet of water, there remains 2 below the foremoſt dam, which is the leaſt that can be to hide the bottom of the river and prevent its being filled up; I ſay that 1 ſluice only of 15 feet high, will be of more effect than thoſe 4 of 9 feet each, and which taken together are conſequently higher by 21 feet.

This difference is from the great ſluice being only once hid 5 feet in the river, and throws alone 10 feet water over the meadow.

The ſmall on the contrary being repeated 4 times, loſe 20 feet, which gives 15 feet difference. The 6 feet remaining proceeds from this, that except the laſt, each of theſe ſluices only ſupporting 2 feet more of water, than that following it, there are 3 which loſe 2 feet each. Another advantage of the great ſluice is, that it throws 2 feet more water between the firſt and 2d ſmall, 4 feet more between the 2d and 3d, and 6 feet more between the 3d and laſt.

Dams, ſluices, or reſervoirs raiſed on the meadow have entirely this laſt advantage; but it is not ſo with reſpect to their difference in height, becauſe of the 5 feet the depth of the river, which is only once reckoned; ſo that by the ſame ſuppoſition, 10 feet will produce the ſame effect as 16. The profil will explain what may appear obſcure in this article. The thickneſs of theſe dams, increaſing in proportion to their height, certainly require a greater quantity of earth; but they diminiſh the number of ſluices and reſervoirs, and, what is more eſſential, there are fewer bridges to guard.

If I ſuppoſe theſe retainers of this height, it is only to make this propoſition more intelligible; for being only neceſſary to have them of timber and clay, and not of maſonry, which is too ſolid for field work, I would not have them exceed 12 feet: this will even be too much for ſluices with vanns; but to prove that thoſe I propoſe are capable of that reſiſtance, it is ſufficient to recollect that their coffers make them real dams, and

tho'

LINES with TENAILLES.

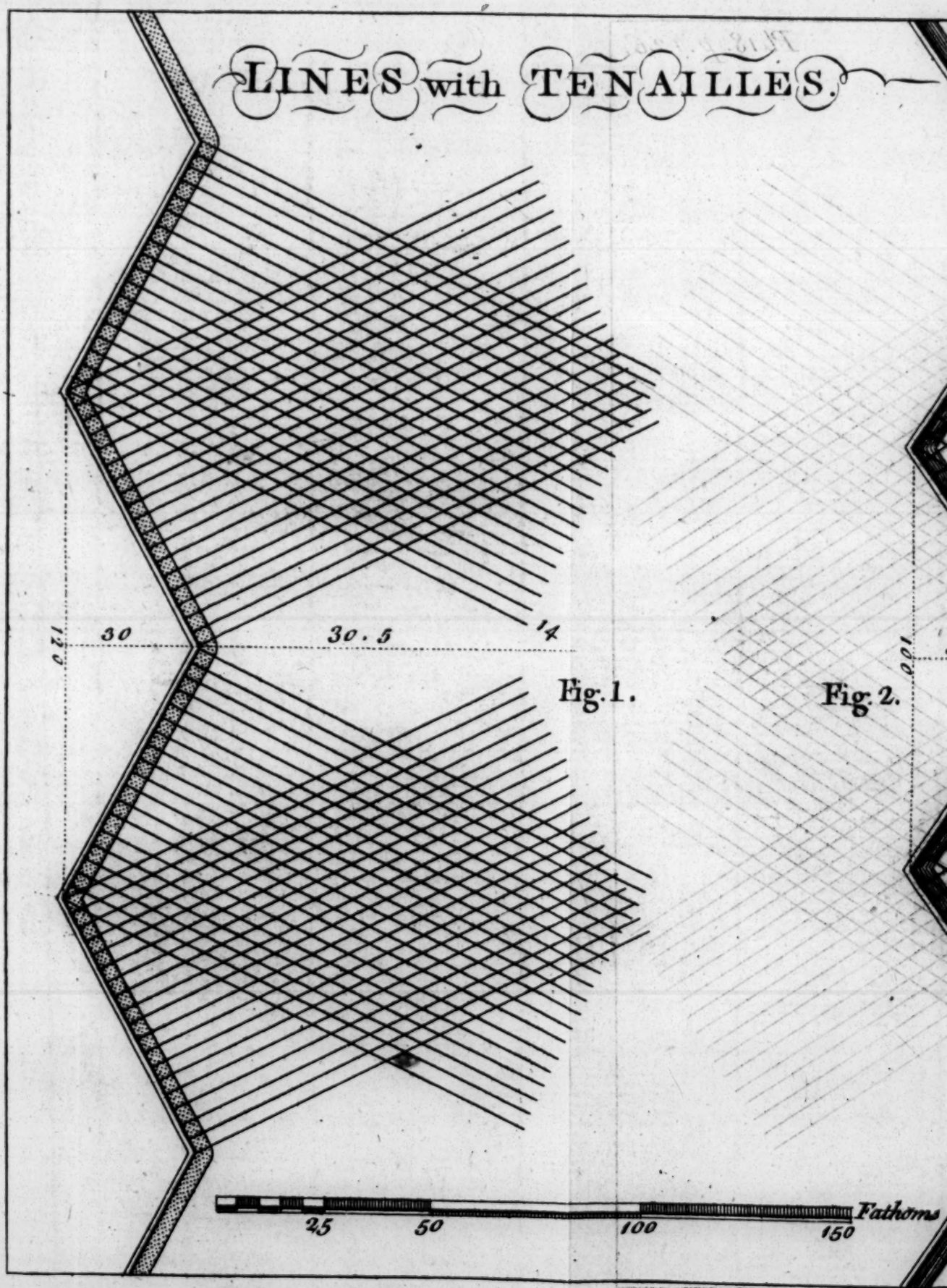


Fig. 1.

Fig. 2.

S.

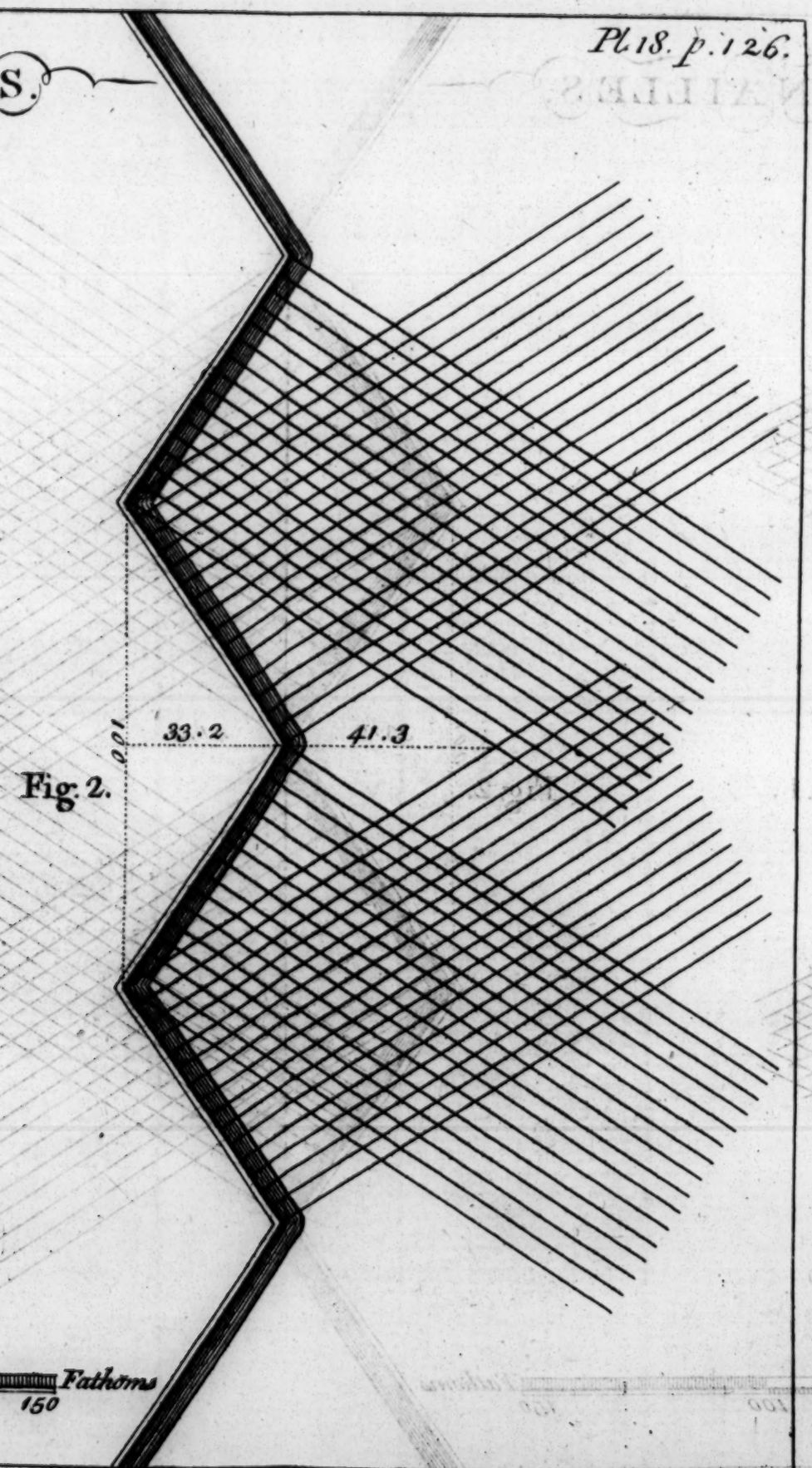
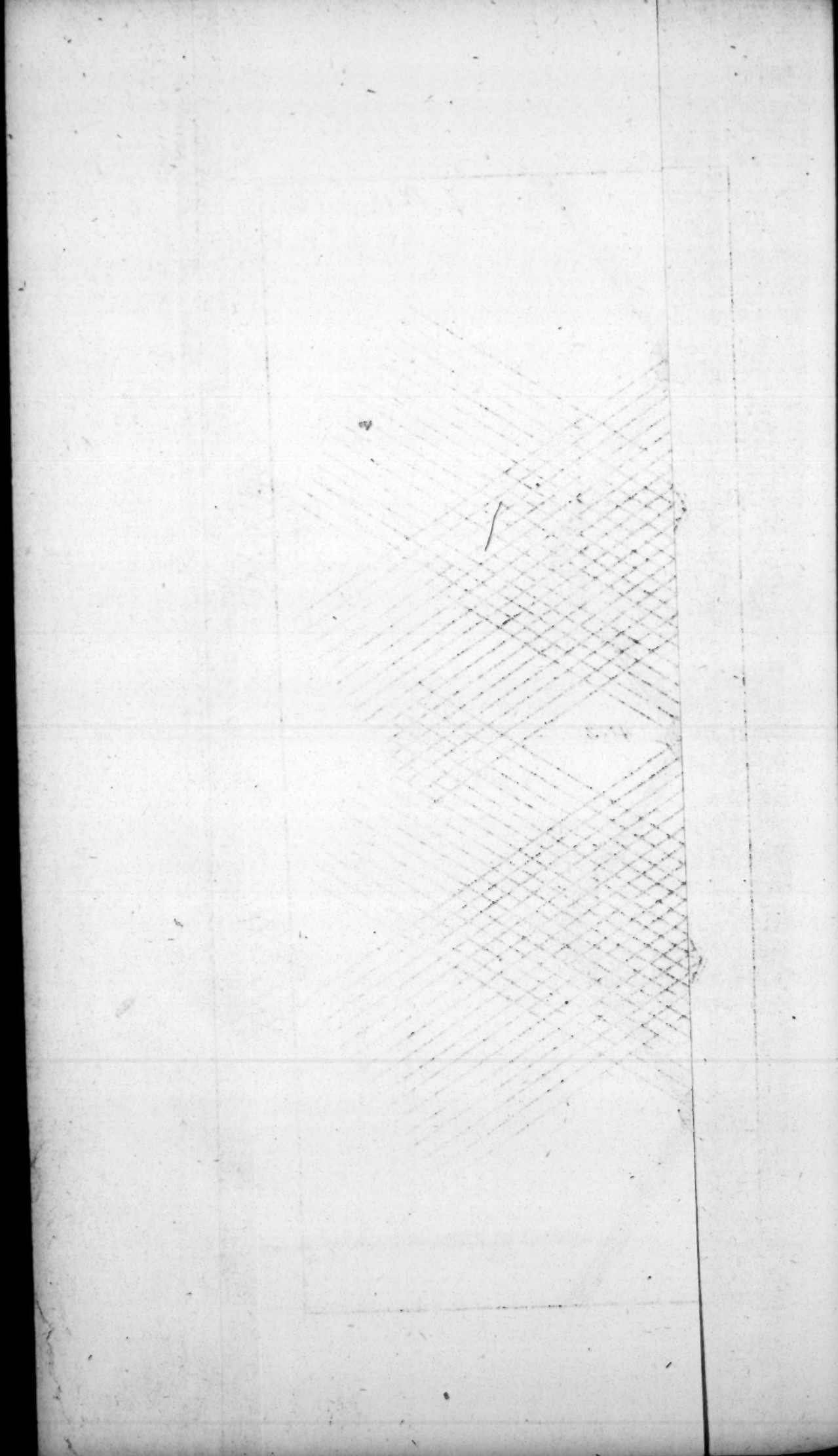


Fig. 2.



tho' they are 12 feet high from the floor, they have not 12 feet of water to ſupport, there being but 5 feet difference between the upper and lower inundations.

When the valley is to be overflown, the lower ſluice is ſhut firſt, and when the water is riſen to a proper height the next is ſhut, and ſo on; otherwiſe the water would not be of the ſame height in all places.

IX. The exceſſive lengths of the dams, cauſed by the diſtance of the places proper to ſupport their extremities, form the 2d inconvenience.

The protection of theſe works being a very material point, they muſt be raiſed in the narroweſt part of the valley, that their heads may be defended by the line, as much as poſſible. As this advantage cannot always be obtained, if it be 60 or 80 fathoms diſtant, a lunette muſt be conſtructed to hold at leaſt 100 men, and turned ſo as to be flanked by the intrenchment. Plate XXVI. Fig. 1.

When this diſtance exceeds 80 fathoms, the ſureſt way is to raiſe a redout on the inundation, or breaſt-works, 30 or 40 fathoms from the oppoſite ſide, which may croſs the dam: the opening next the enemy muſt be covered by a turning traverſe. This muſt alſo have a lunette, which only ſerving as an advanced work, or rather a look-out, may be much ſmaller than the others. Plate XXVI. Fig. 2, 3, 4.

A double parapet raiſed on the dam will ſecure the communications of theſe different works, at leaſt from one piece to another, if the quantity of earth required ſhould be too great. The author means, that a ſingle parapet is to be made only, in caſe the weight of the great quantity of earth is too much, and not as above.

It occurs to my memory, the method taken to conſtruct one of the dams of the *Loutre*. An intrenchment covered only on one ſide, which by its ſeveral turns is ſecured from enfilade, yet oppoſes a croſs fire, ſuperior to that from a point of land, ſtretching out from a hill. This work, an honour to the engineer who

who directed it, ſhews what may be done on ſimilar occaſions.

X. The difficulties found in covering lines by inundations, may be reduced to the 3 following caſes.

Firſt, When the ground, thro' which the river runs, is on a level for too great an extent; how can water be raiſed on a flat ſurface, without means of confining it? This is not impoſſible; but yet I believe never attempted.

2*dly*, When, for the ſame reaſon, the dams are obliged to be made exceſſive long, for want of nearer ground to ſupport their heads, they require much work, and poſts in front; which being liable to be attacked at a time when darkneſs renders the defence drawn from thoſe in the rear, weak and uncertain, give ſmall encouragement to officers charged with ſuch poſts.

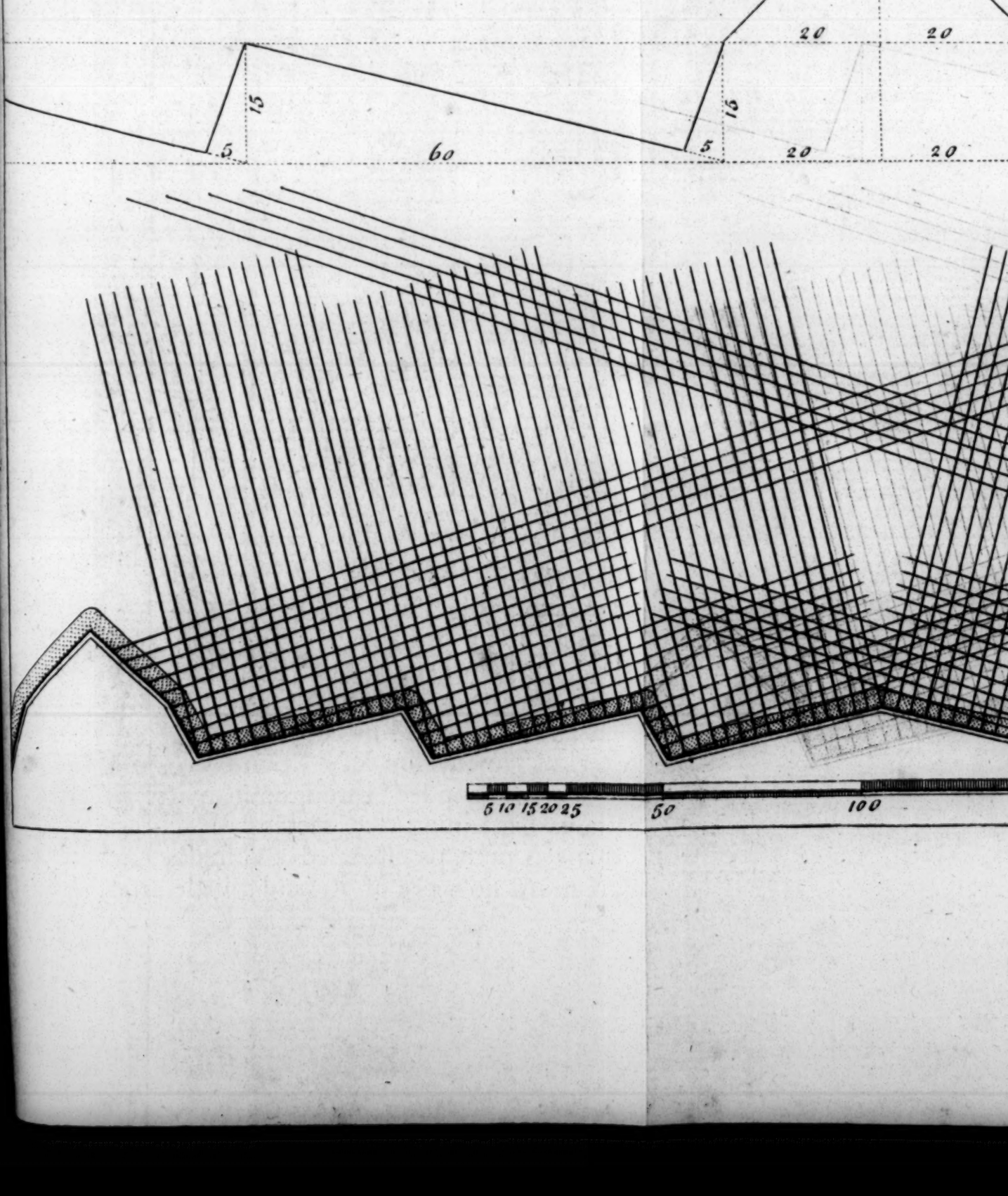
Laſtly, When the great fall of the river renders it neceſſary to multiply the dams, which (without reckoning the increaſe of workmanſhip) are ſo many bridges to guard, they muſt be carefully watched.

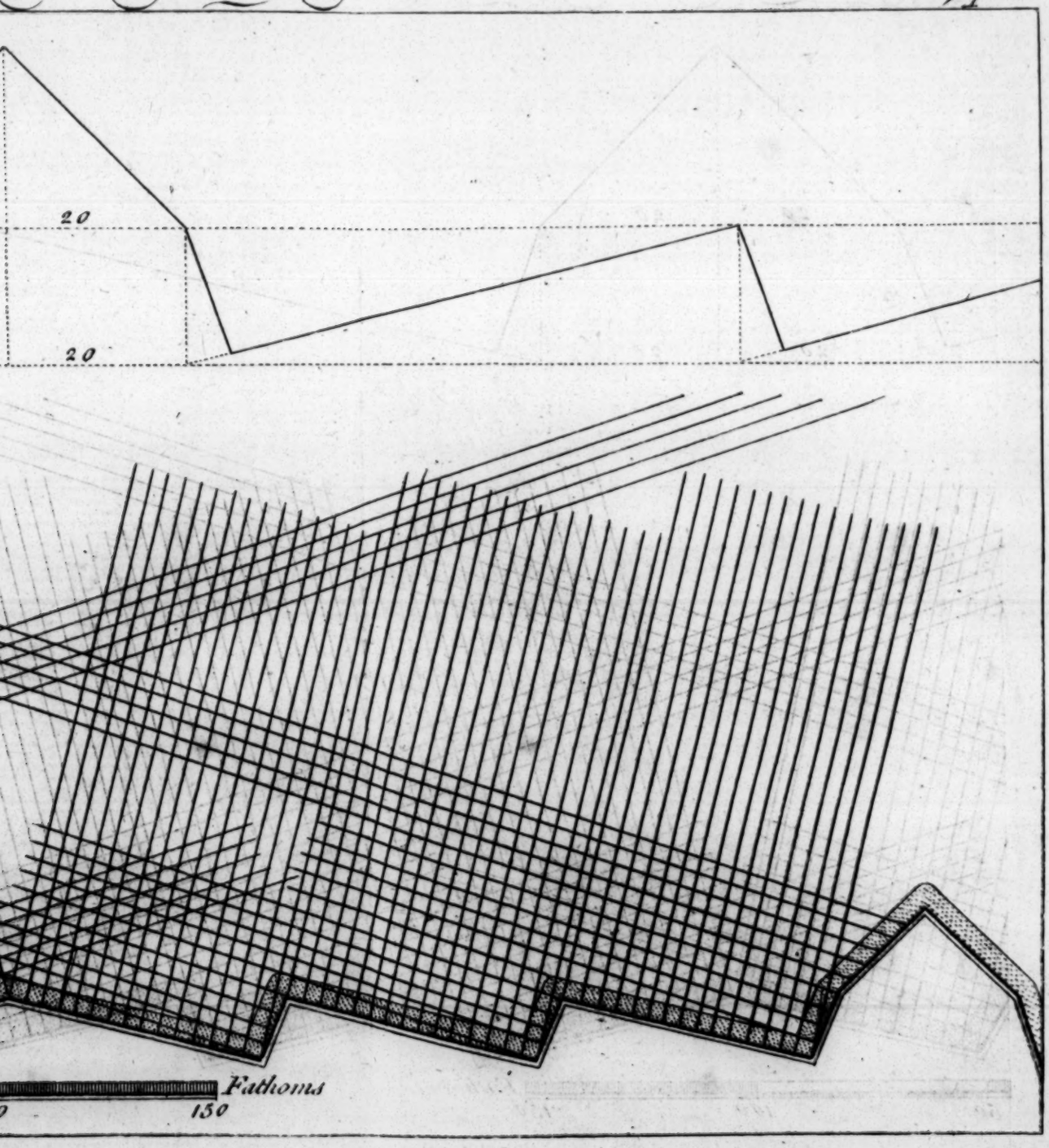
I have ſhewn what is generally done in each of theſe caſes, were I charged with ſuch works, I would avoid theſe obſtacles, and go another way to work.

This expedient is preferable to the common method, by it I would undertake to render the line inacceſſible without theſe ſluices, or troubleſome long dams, or thoſe poſts, advanced and dangerous, and with a quarter of the expence.

This ſcheme, plain as new, I contrived, by order of the court, in 1735, for the lines of the *Spirbach*. This river we have ſhewn runs almoſt every where at a conſiderable diſtance from the hill, flows full to its banks thro' flat and very broad meadows. Neceſſity obliged me to ſeek a remedy for all; I poſitively promiſed an inundation, commanded throughout by ſmall arms; but without explaining the method I propoſed to follow: this was perhaps eſteemed a chimera; be that as it will, I heard no more of it, and a little after, 2 brigades

INDENTED L




20
20
Fathoms
0
150

gades o
charged
propoſe
the opp
Loutre,
never p
the pub
merit b
XI.
the vall
accordi
impract
has onl
My
breadth
is the n
a ſuffici
ly defe
quires
ed its b
I tra
tains a
trenchm
and co
only of
fore th
accord
parts;
extent
6 fe
feet br
accord
will fo
undati
ſtoppe
If
parall
in thi

gades of engineers were detached from the army, and charged with theſe lines. I could not with decency propoſe my ſcheme, as it was not demanded, ſo that the opportunities of executing it at the camps of the *Loutre*, and of the *Queich* in 1743, not taking place, I never produced it, nor even committed it to writing; the publick may judge by the following, if it has any merit but novelty.

XI. I ſuppoſe all the above difficulties united, viz. the valley quite level and of a great breadth, which, according to the common method, renders all ſchemes impracticable, and the river flowing full to its banks, has only 4 feet depth and 2 feet fall in 100 fathoms.

My method leaving me at liberty to preſcribe what breadth I pleaſe to the inundation, I will examine what is the moſt advantageous; if it is too narrow, it is not a ſufficient obſtacle to an enemy; if too wide, it is badly defended, and the dams extending in proportion requires more work. Theſe things conſidered, I determined its breadth between 40 and 60 fathoms.

I trace the ſide 60 fathoms from the curtains and other principal lines of the intrenchment, obſerving in thoſe places where the riſing, and conſequently the fortification winds, to follow thoſe only of a great extent, and to contract the breadth before the others, viz. to run out from 40 to 60 fathoms, according to the greater or leſs projections of theſe parts; as the more it approaches to a right line the leſs extent it will have. Plate XXVII.

6 feet within, trace a parallel ditch from 15 to 20 feet broad above, and from 4 and a half to 6 feet deep, according as the water will permit: the earth dug up will form the dam made lengthways to ſupport the inundation, preſerving 6 feet for a berm, and this dam is ſtopped ſo as to leave no cover for the enemy.

If I have no wheel-barrows, I make another ditch parallel to this at the foot of the intrenchment, which in this caſe follows its windings; if not, it muſt be

contrived that the ſcarp may be ſeen throughout from the parapet.

The breadth thus determined, I trace the retainers at every 2 feet deſcent, that is, according to the ſuppoſition, one at every 100 fathoms. Theſe retainers are formed over the whole breadth of the meadow by dams of earth, and over the ditches by batardeaus of wood; the reaſon of this difference will preſently be ſeen.

The dam on the ſide begins at 3 feet height, and ends at 5; that which croſſes the meadow, ſuppoſing the baſon level, is raiſed every where to 5 feet, though it ſuſtains but 4 feet water in the deepeſt place, which is ſufficient to leave 2 feet at the roof of the upper retainer; but this foot is alſo neceſſary to prevent the water from overflowing.

The earth for the dams of the retainers is taken from a ditch dug above, and as deep as thoſe to which it communicates at the extremities; leaving 6 feet berm at leaſt between the foot of the dam and the ſcarp of the ditch, whoſe ſlope muſt be equal to its height at leaſt.

The dam batardeau adjacent to the ſide of the inundation muſt be made ſo that it cannot be walked over; and as it cannot be waſted by the water, it may be level with the ſurface; it will alſo ſerve as a reſervoir in caſe of neceſſity. How a batardeau can ſerve as a reſervoir is not eaſily underſtood; except the author means, it ſerves to make a reſervoir in caſe of need.

The other is of a different conſtruction; a ſingle vann in the middle, without any more expence, will have the ſame effect as a ſluice, which coſts much more; this vann being raiſed, will fill the ditches, which communicate with each other, in a little time, by cloſing the vann, and throwing the river into its old courſe, it will ſerve as a reſervoir; when an inundation is to be made, ſome planks, ſlipped into the grooves, will ſupport it to a determined height.

The

The only objection that can be made to this method, is the want of water cauſed by filtration thro' the lateral dams. This does not appear probable to me, as they are very low and thick; but ſuppoſing this filtration, it can be no inconvenience, as we never want a ſupply of water from the river. If it is feared that the vanns are inſufficient, the ports of the dam, which form the reſervoir, muſt be lowered by ſome inches, ſo as that they are higher as they deſcend with the ſtream; the conſequence of ſecuring the entrance of the water is manifeſt, as upon this the whole depends.

This method is equally good to cover lines entirely by inundations, and correct the defects of thoſe already conſtructed after the uſual method.

Observations on the ninth Chapter.

As few countries are without rivers or brooks, the manner of taking advantage of their courſes, in retrenching camps, is here particularly conſidered; as the author ſeems not eaſily underſtood, an explanation of ſo uſeful a ſubject will, I hope, be of utility.

He ſays, that when a large river runs in the front, it forms almoſt an impenetrable barrier, by the aſſiſtance of few works; but as its great length cannot every where be ſufficiently guarded, the enemy may paſs it either above or below, and attack the camp in rear or flank, as he finds moſt neceſſary. Since the river is a ſufficient defence in the front, the attention of a general ſhould be confined to the ſecuring his flanks and rear, either by works in thoſe places, which are eaſy of acceſs, or by moraſſes, if there be any near, or by all the means, that nature and art affords: if the enemy croſſes the river with an intention to hem him in on all ſides, the general muſt know whether his camp can be forced or not; if not, whether he has means to ſubſiſt his army till the enemy is obliged to retire.

If a river is not very large, and its courſe may be carried round the greateſt part of the camp, or has a

conſiderable bent, ſuch a ſituation is certainly very favourable, provided the ground on the oppoſite ſide does not command the works of the camp; it is alſo very advantageous to have a ſufficient quantity of ſweet water ſo near the camp, that the enemy can by no means cut it off, for the uſe of both men and cattle; all other neceſſaries but that may be tranſported from other places.

If a river is ſo ſmall as to be eaſily paſſed, dams may be made at proper diſtances, to raiſe it higher; or if the ſituation is favourable, an inundation may be formed, of ſuch extent, as not to be croſſed without the utmoſt difficulty. In both caſes, care muſt be taken to prevent the enemy from cutting theſe dams, and to let out the water; for which reaſon, ſtrong guards muſt be placed near them, and ſecured either by a good redout, or any other ſuch work, the nature of the ſituation will admit.

If there is a riſing ground within 60, 80, or 100 fathoms of the river, the camp muſt be placed upon it, and an inundation formed, if it can be done between the river and camp: when that diſtance is too great for ſuch works, 2 ditches may then be made nearly parallel to the riſing ground, within 40 or 60 fathoms from each other; theſe ditches muſt be croſſed by 2 others, ſo as to bring the water from the river into the former; or if the ground between is low, to form an inundation. The reader muſt be ſenſible, the whole ſecurity depends intirely on the well guarding the dams which keep up the water; for if they are not, the enemy may paſs them, being ſo many bridges ready made, or demoliſh them, as he finds moſt convenient.

When the water of a river is to be raiſed to any moderate height, the author prefers a ſingle dam of a ſufficient height to 3 or 4 ſmall: thus if the water requires to be raiſed 10 feet at the lower end, and the banks are 5 feet, he prefers one dam of 15 feet high to 4 of 9 feet, placed ſo as to raiſe the water to the ſame height

above.

above. His reaſons are, that the height of the 4 dams amounts to 36 feet, therefore the difference between this and 15, the height of the one is 21 feet; and the 4 require 4 guards inſtead of 1, which fatigues the army. How it happens that the 4 raiſe the water no higher than the 1, is thus; the firſt or lower will raiſe the water 4 feet above the bank; and as 2 feet of water above the bank is reckoned the leaſt that can be allowed to hide the bank; the 2d is placed where the height of the water is 2 feet above the bank, therefore can raiſe the water but 2 feet higher; and the 3d and 4th will raiſe the water no higher for the ſame reaſon; ſo that the loweſt raiſes the water 4 feet, and the three others together 6, which makes 10 feet, and is the ſame as 1 of 15 feet ſunk 5 into the river.

To ſhew how much the work of the 4 at 9 feet high exceeds the 1 at 15, it ſhould be obſerved, that the preſſure of water againſt a perpendicular ſurface is equal to the weight of a triangular priſm, whoſe height is equal to the breadth of the river, and the baſe and the poſales right angle triangle, 2 ſides of which are equal each to the height of water. Since the height of theſe priſms are the ſame, viz. the breadth of the river, and their baſes ſimilar triangles, and theſe ſimilar triangles are as the ſquares of 1 of their ſides, the total preſſures are to one another as the ſquares of the heights of the water: and as the ſolid content of theſe dams muſt be proportional to the weights they ſupport, the quantity of the work in a dam of 15 feet high, is to that of 1 of 9 feet high, as the ſquare 225 of 15 is to the ſquare 81 of 9: and as there are 4 of 9 feet high, and 4 times 81 makes 324, the quantity of work in the 1 is to that in the 4, as 225 is to 324, or as 75 to 108; which is not ſo great a difference as might have been expected. This is upon the ſuppoſition, that all the dams ſupport a quantity of water proportional to their height, which is not the caſe here; whereas it ſhould only be the difference between the height above and

below each dam; and as this difference is only 2 feet in the 3 upper dams by ſuppoſition, if therefore we ſubſtract 3 times the ſquare, 49 of 7, which is 147 from 324, the difference will be 177, and hence the work in the 1 will be to the work in the 4, as 225 is to 177; or as 75 to 59; ſo that the 4 require leſs work than the 1; or at leaſt no more; becauſe the foundations ſhould be conſidered.

There are other reaſons to prefer 4 dams of a leſs height to 1 of a greater. For it is not always practicable to make but 1 dam in a river, ſo as to keep up the water to a certain height above the camp. Since, if the ground is flat to a conſiderable diſtance, the water by overflowing will ſpread ſo much below, as to prevent its riſing above. Another diſadvantage attends a ſingle dam, that if it ſhould break either by a ſudden ſwelling of the water, or by the want of a ſufficient ſolidity, it will be much more difficult to repair than any 1 of the 4. To find the dimenſions of the profil of a dam, ſuppoſed to be of the ſame form as repreſented by fig. 34, plate 19, of my ELEMENTS of MATH. Whoſe baſe of the ſlope being 1 5th of the height, we muſt conſider, that common earth is nearly twice as heavy as common water, and by following the ſame ſteps as in art. 510; by ſuppoſing $n = .2$; and take w for the whole weight inſtead of 2 thirds, we ſhall find the thickneſs of the profil above to be 22 parts of the height. Thus if the height be 9 feet, then 9 times 22 gives 2 feet nearly; but if the height is 15 feet, then 15 times 22 gives 3.3 feet, or 3 feet 4 inches, for the thickneſs above; if to which we add 3, 1 5th of the height 15, for the baſe of the ſlope, we get 6 feet 4 inches for the baſe of the profil. It is ſuppoſed, that the caſe of the dam is made with boards, ſtakes or faſcines, to prevent the water from waſhing away the earth.

The author reduces the difficulties of ſecuring lines by water to three, viz. when the low ground is if too great

great an extent, to form an inundation, to the great extent of the works which attends it; and when the deſcent of the ſtream is ſo great, as to require ſeveral dams to the number of poſts to be guarded. The 2 laſt of theſe inconveniencies have been already mentioned; as to the firſt, it is remedied as follows. If the flats are conſiderably extended, and a riſing ground terminates them, upon which the camp is ſuppoſed to be: he propoſes to make a ditch, from 15 to 28 feet broad, nearly parallel to the intrenchment; and another of the ſame width, parallel to and diſtant from it, from 40 to 60 fathoms: theſe two ditches are joined by others, nearly at right angles to them; and the earth taken out of them ſerve to form dams, by which the water is kept up to a proper height, in the ſame manner as thoſe deſcribed above do in the river: he then propoſes to make a kind of wooden ſluices with ſhutters, acroſs the 2 firſt ditches, where the dams meet them, to prevent the water from running out that way. This done, the lower ſluices are ſhut till the water is of a ſufficient height, then the next ſhut, and ſo on to the laſt.

Thus the ſubject is clear; yet there remains 1 great difficulty in the execution, which the author does not mention; all he ſays is, that the importance of ſecuring the entrance of the water into this baſon is ſelf-evident: it appears to me, that the lower dam is what muſt be well ſecured, and not the entrance of the water; or by cutting a paſſage through it, the water muſt run out. As to the guarding the entrance of the water it is immaterial when the inundation is once formed, which muſt be done before the enemy can prevent it, otherwiſe it is impoſſible to make ſuch a work when he is near; and to prevent cutting the lower dam, I can ſee no other remedy, than to make it where the river runs ſo near the intrenchment, as to be defended from thence by cannon; the defence of ſmall arms is inſufficient, ſince the enemy may bring a greater againſt it. No more need be ſaid, than that a good engineer,

who is upon the ſpot, may conſider, whether ſuch a ſcheme is practicable.

CHAPTER THE TENTH.

I. *Intrenchments to be made in caſe of a river.* II. *Plans of works to paſs it by open force.* III. *To repaſs it in the preſence of an enemy.* IV. *Another ſcheme.* V. *Example of the camp at* Nordheim. VI. *Precautions to be taken to prevent the paſſage of rivers.* VII. *Remarks on* Folard's *epaulements.* VIII. *Continuation of theſe remarks, and ſchemes of the author.* IX. Folard's *ſchemes.*

I. THE various operations a general may be obliged to undertake to paſs or repaſs a river, or diſpute the paſſage with an enemy, requiring the conſtruction of many different works, are the ſubject of this chapter. Theſe works are ſeldom of ſo great extent, as to be ranked with lines, yet as their figure reſembles them more than any other, I thought they could not be better placed than following intrenchments covered by rivers or inundations.

I ſhall treat of the works alone, avoiding as much as poſſible to enter into the various circumſtances relative to the motions of troops; not to depart from my ſubject, or repeat what unneceſſarily authors have wrote; tho' ſcarcely any thing has appeared on this kind of fortification, yet it is not ſo with the other; it having been ſo copiouſly treated, as to leave no room for improvement.

II. When a river muſt be paſſed by open force, by natural fords, or the means I ſhall ſpeak of have rendered it practicable, by boats, on floats, or ſwimming, it is abſolutely neceſſary, that ſo ſoon as the firſt troops have paſſed over, and began to intrench, to make convenient and ſure communications.

If

If therefore bridges muſt be flung over; but if there was only one, a fort ſuch as we deſcribed in chap. 2. will be inſufficient, not being large enough to contain the troops that muſt paſs; the firſt that arrive will be ſtraitened in the defence, or run the riſk of being taken off from the counterſcarp.

Beſides this work, which will be ſufficiently lined with 8 men or leſs to a fathom, and where the reſt of the troops muſt file off, a ſpot of ground muſt be found where they can intrench or barricade, by fellings, or *Chevaux de Friſe*, as they arrive.

This halting place, cannot be better placed than on the flanks of the intrenchment, which projecting beyond them will flank them; without this, they could not have too much depth; I think there cannot be leſs than 60 fathoms, that the troops may not be confuſed by thoſe who file off in their rear.

As theſe intrenchments extend in proportion to the numbers that enter, one of the extremities muſt be left open: *Santa Cruz*, to remedy this, propoſes to croſs by branches the intrenchment down to the river at every 600 paces, or to ſupply it by a redout.

This precaution is good, but then the ground is broke, incumbered and diminiſhed. If the river is narrow this additional work may be avoided, as the enemy cannot make an attac, without being flanked by the intrenchment on the oppoſite ſide, which ſhould be raiſed.

It is therefore neceſſary, if not indiſpenſible, according to this judicious author, to conſtruct a 2d bridge, when the firſt is finiſhed, was it only to avoid the danger of having the communication of thoſe that paſs firſt, cut off, if the artillery, or any other accident, ſhould damage the firſt bridge.

The intrenchment, either entirely, or the greateſt part, muſt be included, between the 2 heads, from thence reſults this great advantage, that if one of the bridges ſhould be broke, the remainder Pla. XXVIII.

der of the army can march to ſupport the work that covers it, and ſuppoſing the line finiſhed, it is in no danger of being flanked.

The heads of the bridges have gates, as they muſt ſubſiſt ſome time, alſo communicate to the right and left, but none are made in the adjoining lines. When all the army, or at leaſt a number nearly equal to the enemy, have paſſed with the artillery, if they would advance, each battalion throws down the parapet and the counterſcarp before it into the ditch, ſo as to make an eaſy ſlope to march out in battle, and thus avoid the danger of filing off.

We ſee what care is neceſſary in ſuch hazardous enterpriſes; they muſt endeavour to deceive the enemy, to have time to raiſe the intrenchment and the batteries which defend the acceſs to the bridge; this intrenchment ſhould be favourably ſituated, either by ſuperiority of ground, or an elbow in the river, which helps to croſs the fires in front. *Laſtly*, the troops on the other ſide muſt work half at a time, each having his arms grounded 2 paces before him, and the other half, prepared for an engagement, muſt cover them: they ſhould relieve each other hourly, and if the enemy attac them before the parapets are formed, they muſt defend themſelves in the ditch, where they will be covered by the counterſcarp, and better aſſiſted by the fire on the other ſide, which by this means they will not intercept.

III. Of all military operations, perhaps the laſt is the moſt dangerous, except that of repaſſing rivers in the preſence of an enemy, where one part of the army is conſequently liable to be attacked in the rear, when the other cannot aſſiſt it.

Few have touched on this important ſubject: *Feuquieres* would have the troops incloſed by good lines, whoſe extremities, ſupported by the river, are flanked by the fire of ſome large redouts on the oppoſite ſide; that the bridges, for he ſuppoſes many, and there cannot

not be too many in ſo critical a ſituation, that the bridges, I ſay, be covered by a 2d intrenchment, well lined with infantry; independent of this, a redan, which ſerves to break up the bridge with ſecurity, as alſo to cover the rear of the retreat.

He alſo recommends theſe other precautions, which though they do not immediately belong to fortification, may here be uſeful: "The light and heavy baggage, "ſays he, ſhould go before the army a conſiderable "time; the cavalry alſo before the infantry; the firſt "infantry that paſs ſhould be poſted and intrenched "on the other ſide, in redouts, which ſhould protect "the flanks of the army; nothing of this motion "ſhould be ſeen by the enemy, that they may not at-"tac on the march, becauſe the diſorder in ſuch caſes "is to be dreaded; and if the enemy are in ſight of "the camp, the army muſt march in the night only; "but the 2d intrenchment, the redans and redouts, "muſt firſt be lined; and a time choſen, when the "enemy may not be able to ſee the motion."

On theſe inſtructions, I ſhall propoſe the following plan, tho' I do not think myſelf obliged ſtrictly to adhere to them.

Theſe works incloſed one within another, and conſequently of different contents, are evidently deſigned that the troops, ſucceſſively retreating, may be ſufficient to line them, in proportion as their numbers decreaſe: when there remains but 6 or 8 battalions, it is certain they may be forced in that vaſt intrenchment, which contained the whole army; whereas they are in a ſtate to ſupport themſelves in the heads or lunettes of the bridges; but, I find the difference of extent between the line and theſe pieces too great for one intrenchment.

Suppoſing it neceſſary to repaſs a river, when not maſter of the other ſide; (which is rare, and ſuppoſes the enemy much ſuperior in numbers) to this difficult operation would be joined that of paſſing by open force;

force; but as that is not the caſe here, the redouts *Feuquieres* propoſes, are only proper to ſecure the heads of bridges againſt ſurpriſes, or the danger of being attacked, before being reinforced by ſome light troops: a ſingle line ſhould be preferred or added, becauſe ſuch a precaution is neceſſary, which will form a communication from the right to the left, and flanked with a greater fire every part within reach.

Plate XXIX. IV. I now come to the plan I mentioned, which needs no deſcription, the plate being ſufficient to explain every thing. I ſuppoſe with *Feuquieres*, that we are generally freed of all our baggage, and whatever cavalry we think we ſhall not want, with the infantry to line the intrenchment on the other ſide, paſſed over; this infantry may be 4 battalions, I here ſuppoſe 6.

If it is thought theſe detachments would weaken the army too much, the exterior line muſt be put into ſuch a ſtate of defence, as to ſupply this defect before they are ſent over.

This intrenchment and the works being finiſhed, the 3d line begins the retreat, followed by the 2d, that is, by the reſt of the cavalry. The ſquadrons are divided into 3 detachments, and each detachment paſſes over the bridge neareſt to it.

This motion is made in the night, unknown to the enemy: yet if they ſhould diſcover it, and take that opportunity to attac, which they will do in the centre, to avoid the fire of the intrenchment, on the other ſide the river, the infantry at the extremities of the line ſeparated by the traverſing lines, muſt abandon that poſt, and replace that of the cavalry in the centre.

If all is quiet, theſe 12 battalions file off, 4 over each bridge: the 6 battalions in column begin their march, and are followed by the 24 others, 1 3d over each bridge.

For greater ſecurity, theſe bodies may be removed alternatively, that is, from 2 take 1, that the remaining

ing by their extent may be able to line the parapet; they may even be doubled, the battalions being ſuppoſed here 6 deep.

At length only the redans and the intrenchments which ſupport them are occupied; they retreat from theſe, beginning by the intrenchments, and leaving in each redout within the bridge heads but 2 companies of grenadiers, who after having taken up or deſtroyed the bridges, retire in boats furniſhed with poles and oars, & and drawn to the other ſide by 2 or 3 ropes faſtened to each.

Theſe redouts ſhould be formed by 2 rows of palliſades, 1 foot diſtant, and if neceſſary, with a 3d row of inclined palliſades.

The troops, thus ſucceſſively occupying intrenchments proportioned to their numbers, are always able to line, and conſequently to defend them.

They will alſo be vigorouſly ſupported by the fire from the other ſide of the river, the batteries of which nearly flank the line, the traverſes and redans. Theſe laſt pieces, and redouts, are flanked as well by the 6 battalions, as thoſe who paſſed over, before it was neceſſary to defend them.

I traced the flanks and traverſes indented, that the cannon might flank them the better.

Tho' this camp only ſuppoſes 60 battalions, it would be ſufficient for 80, by replacing the 20 ſquadrons of the 2d line by ſo many infantry, from whence they may repaſs the river, ſo ſoon as the works ſhould be in a ſtate of defence; this cavalry ſhould be poſted on the right and left of the exterior intrenchment, where they would be covered in front by the fire of the branches, and in flank by that of the oppoſite ſide; for greater precaution ſome redouts may be thrown up there.

Should this ſcheme be objected to, as requiring too much work, I anſwer, that the ſafety of the army requires it, and nothing but tools are wanting, for there are more troops than neceſſary to execute it in a very

ſhort

ſhort time, without diſplacing them. As to the intrenchments on the other ſide the river, if the banks on both ſides are on a level, or that on the oppoſite high, it is ſufficient to ſink it in the form of a trench, by throwing the earth on the outſide, which will ſhorten the work. Whatever form it is done in, we muſt always begin at the extremities, theſe parts being deſigned to defend the flanks of the exterior line, will be moſt wanted. As to the batteries, ſo far from being ſunk, they muſt be raiſed and placed ſo as to command at a diſtance in front.

V. The prince of *Conti*'s method to repaſs the *Rhine*, in 1745, with the army under his command, is ſo good, that I ſhould have nothing more to propoſe, did not circumſtances vary. The following is a relation of this event, by the chevalier *de Clairac*, my nephew, who was preſent.

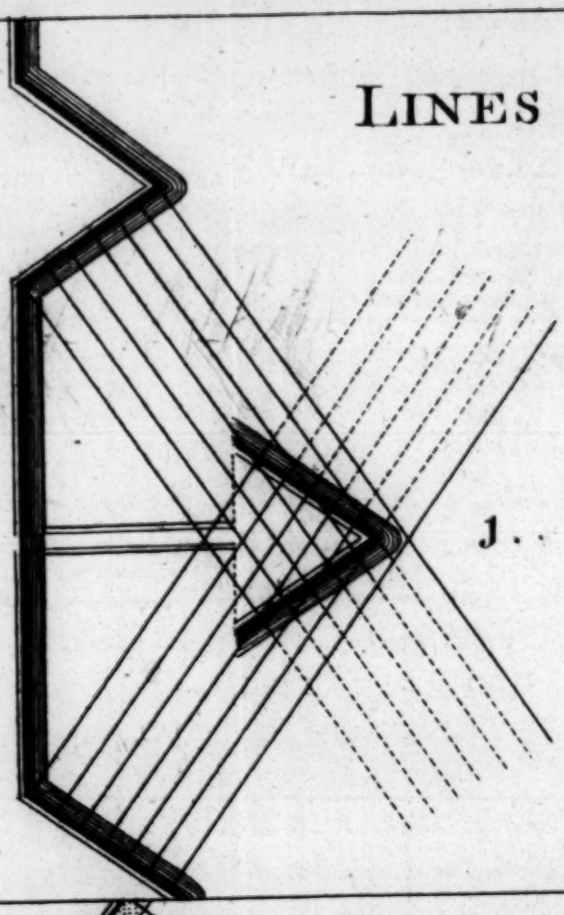
The right wing of our army, ſupported by the rivulet and moraſs of *Hoffeim*, was covered by redans, each large enough to contain 1 battalion; we alſo poſſeſſed the village of *Bobſtat*, within reach of which were the only openings by which the enemy could enter the plains. Plate XXX.

The left, ſupported by impracticable moraſſes, and covered by the little river of *Weiſchnitz*, only acceſſible by the cauſeway and bridge of *Wattenheim*, a large village towards the extremity of the line.

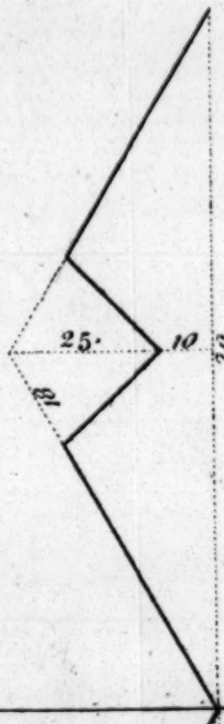
While the redans on the right, and ſome others towards *Bobſtat* were raiſing, we conſtructed 5 redouts at ſome diſtance from the tails of the 2 bridges we had flung over below *Rindurkeim*. Theſe redouts were ſo ſituated, that the enemy could not penetrate until they had forced them all; which was the more difficult and tedious to be done, as being well guarded, they reciprocally defended each other, and could not be attacked but 1 after another.

All our baggage being ſent over the *Rhine*, and the works finiſhed early next day, ſome troops of cavalry, 1 regi-

LINES with LUNETES

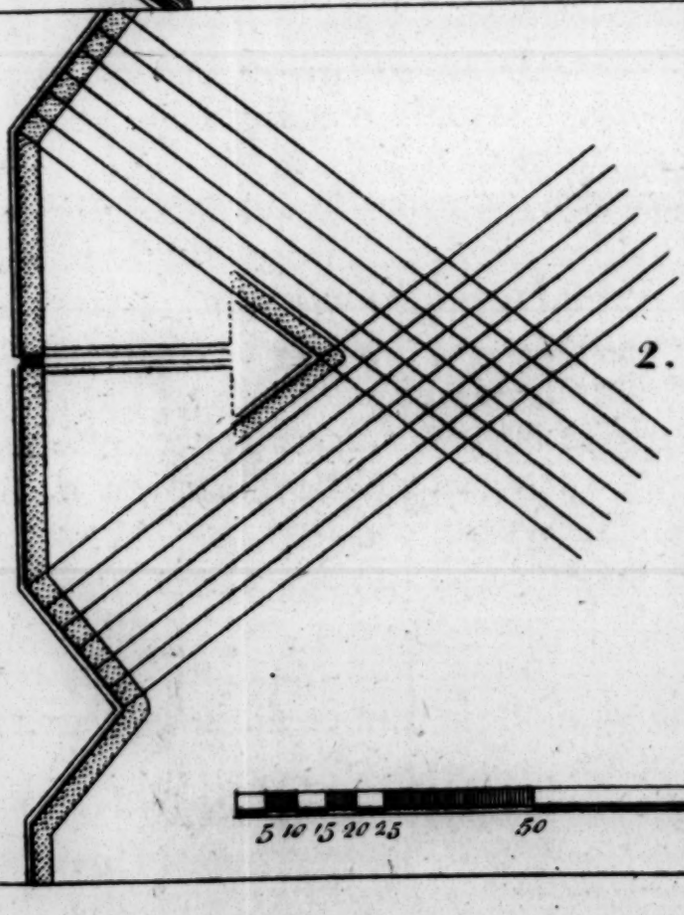


1.



3.



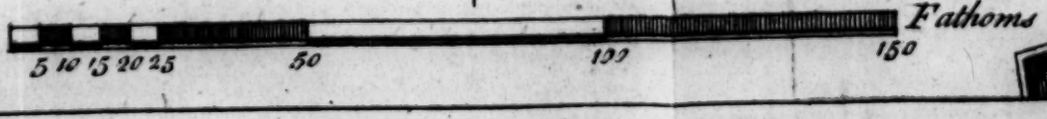


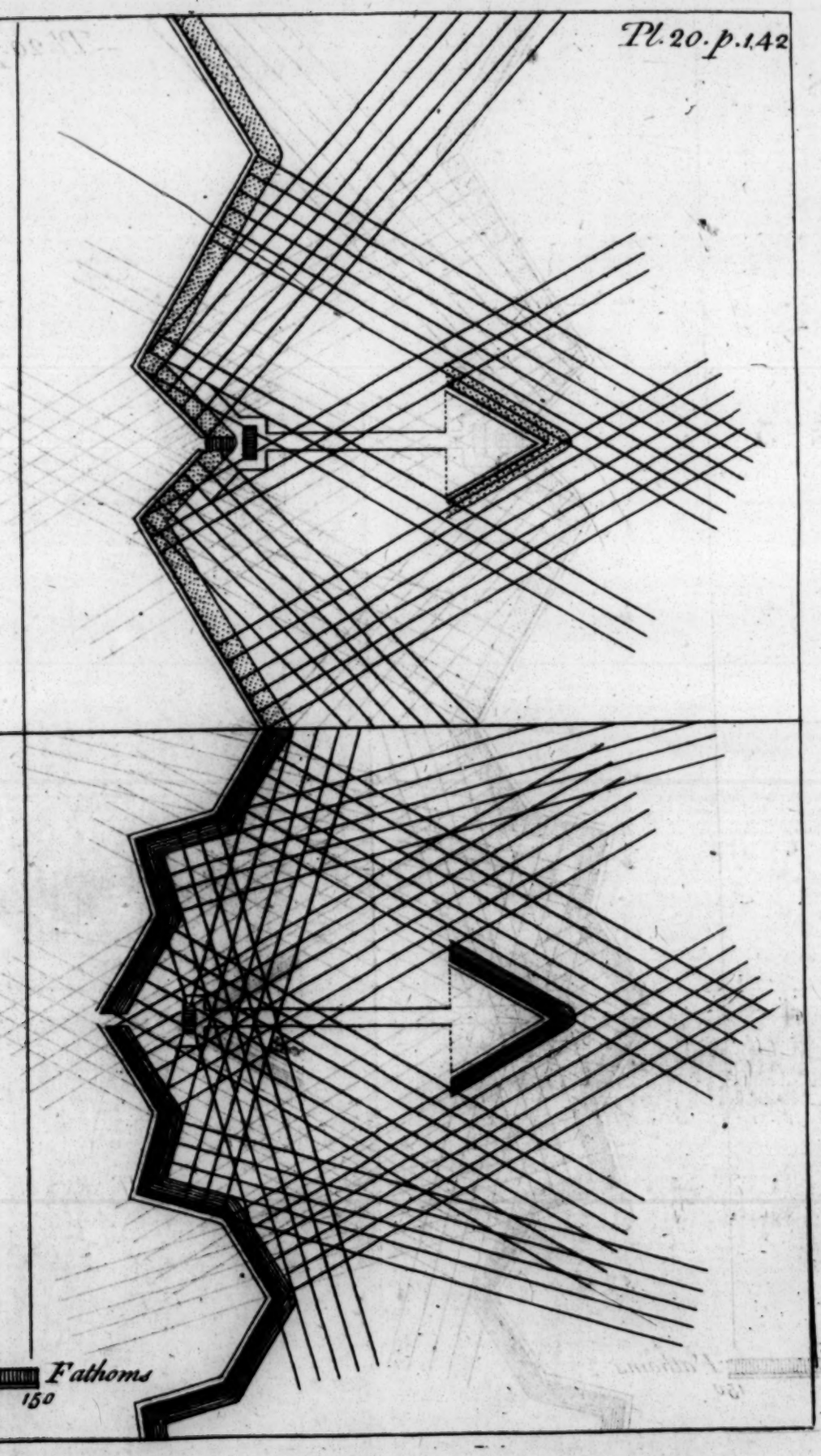
2.

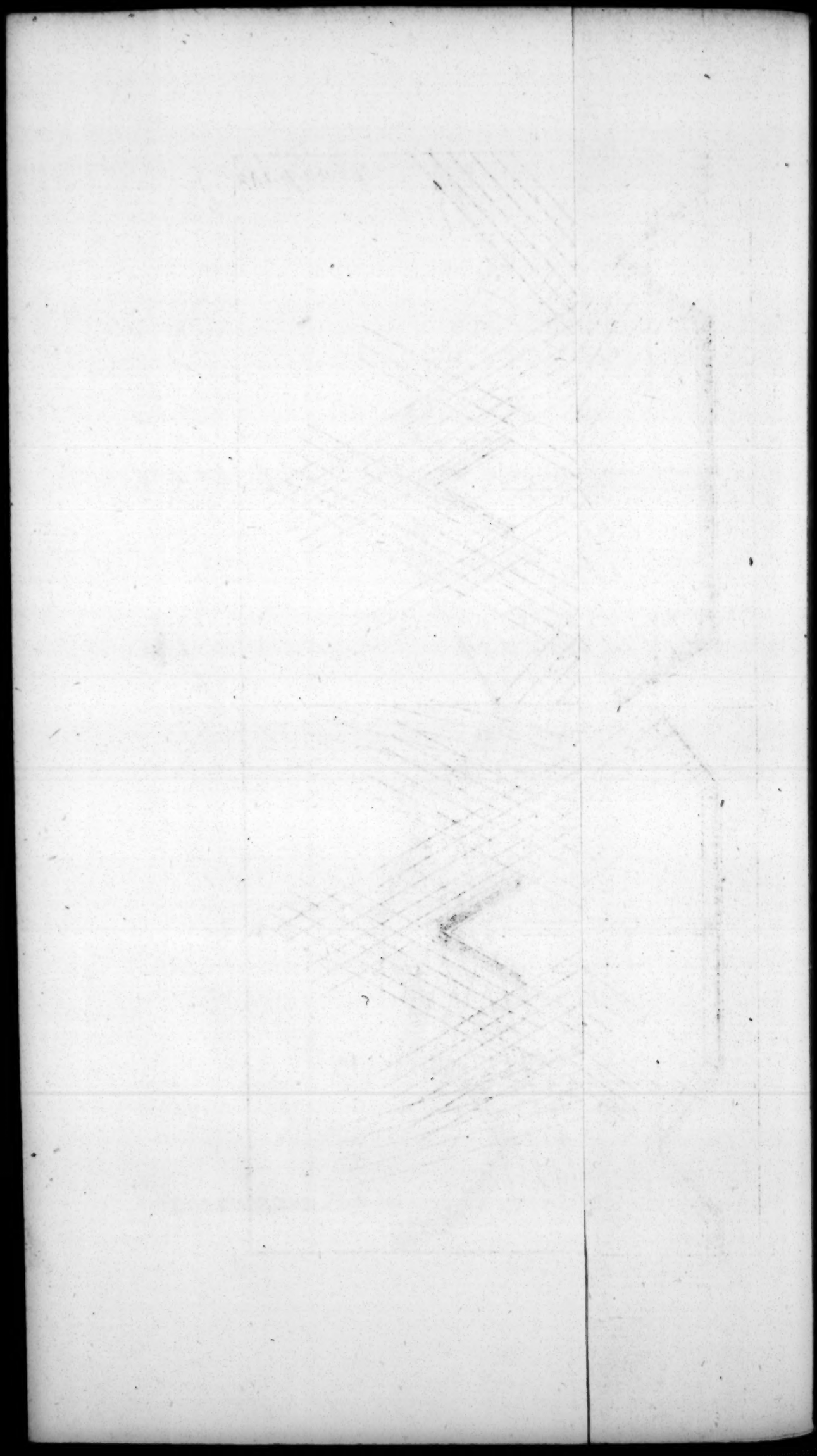


4.






Fathoms
150



1 regiment of huſſars, and the independent companies were drawn up between *Bobſtat* and the rivulet, and the infantry brigade of *Britany*, deſigned for the rear-guard, were poſted in the hedges beyond *Nordheim*, the army, being drawn up at the head of the camp before day, began to file off in 5 columns, 3 of infantry by battalions in front, and 2 of cavalry; the artillery, divided into 4 parts, were in the intervals.

The troops which guarded the openings of *Bobſtat*, being on their march, were attacked by 6000 huſſars, croats, or pandours, commanded by general *Trips*, who made ſome ſquadrons give way, and falling on the reſt, put them into diſorder; but the whole quickly rallied behind a reinforcement of cavalry, ſent from the main body, who having ſtopped the enemy, rejoined their column.

They were yet more unlucky on the right. Thoſe who paſſed by *Wattenheim* were vigorouſly repulſed before *Nordheim*, and the enemy reſolutely followed the troops who retired from this poſt, till the fire of the firſt redouts ſtopped them, and the brigade of *Britany*, facing quickly to the right about, purſued them cloſe with fixed bayonets, and drove them back to the very village.

In the mean time the army filed off leiſurely; when the main body and artillery had paſſed the *Rhine*, the rear-guard, and thoſe of the redouts, which we ſucceſſively evacuated, followed.

We had no more than 15 companies of grenadiers to line the intrenchments of the tails of the bridges. They all came over except 100 men, who ſtaid while the bridges were taken up, which was done ſo ſpeedily, that the violence of the wind and current having broke the cables, we were obliged to burn ſome of the boats.

The bridges being at ſome diſtance from the ſhore, the 100 men ſet fire to a heap of faſcines and tarred wood,

wood, which ſerving as a ſhelter, gave time to this little body to embark in the boats which waited for them.

This famous retreat, made in eight hours, without the leaſt confuſion, coſt us only 200 killed, wounded, and priſoners, the enemy loſt above 1000.

There are few examples of paſſing an army over ſuch a river as the *Rhine*, in broad day, with ſo much order, and little loſs, eſpecially being purſued by a conſiderable army, compoſed in part of light reſolute troops. The choice of a camp, poſſeſſing all the advantageous poſts, diſpoſition of the troops, always within reach to ſupport each other; artillery, redouts, and works, the detail of many other circumſtances not applicable to the preſent ſubject, prevents my ſaying more of ſo ſkilful a general.

The 5 redouts, capable by their poſition to cover a numerous body, have in ſome meaſure the ſame effect as my exterior line. The bridges were covered by 1 work only, yet the ſize and figure alſo anſwered the intent of the 2 redans and the intermediate intrenchment. The curtain was broken, the ſaliant parts being ſo far diſtant from each other, as to require theſe new flanks; laſtly, 2 batteries on the oppoſite bank defended the acceſs to this head.

Theſe works, much leſs conſiderable by their extent, than by their judicious diſpoſition, were ſufficient to ſecure the retreat of a good army, well conducted, full of confidence and courage, ſo that any additional works would have been ſuperfluous; but if I may expreſs my ſentiments, I believe M. *de Artus* who directed them, would not have thought them ſo, with an army that had been beat, diſcouraged, and where it is to be feared, the moſt exact order is not maintained; in this caſe I think my ſcheme more agreeable.

VI. Having treated of paſſing rivers, I may be accuſed of neglect, if I omitted the means of preventing theſe paſſages.

Is it not a paradox to aſſert, that this operation is as difficult as the other? Yet if not in itſelf, at leaſt by circumſtances. Nothing is more difficult than to paſs when an experienced enemy oppoſes the paſſage; it is even impoſſible, if they lodge firſt on one of the banks; yet nothing is more difficult than to hinder the paſſage, when there are many fords, or places where bridges can be flung over; to guard theſe places entirely reduces an army; and in this caſe, as *Feuquieres* obſerves, "the general, who extends his army, has the leaſt proſpect of ſucceeding."

The beſt to be done on this occaſion, is to throw up ſmall redouts, not only in ſuſpected places, but in their intervals, and near enough each other to form a chain of centinels and patroles, and if the country is on our ſide, 15 peaſants is ſufficient for each, who by theſe works will not be in danger of being ſurprized in the night, by parties who may croſs in boats; when they diſcover any extraordinary motion, they make an appointed ſignal, which being repeated from poſt to poſt, paſſes immediately from right to left, time enough for the adjacent troops to arrive: this I ſaw practiſed in *Alſace* during the laſt 2 wars.

When there is an iſland within reach, it muſt have troops poſted in it, and ſome works to cover them; at leaſt, all the wood and buſhes ſhould be cut down, that nothing may paſs unſeen. Had we taken this precaution at *Spire* in 1735, the Imperialiſts could not have burnt our magazines, cloſe to the gate of the town, with bombs and hot bullets, which fortunately were inconſiderable.

In preſcribing theſe precautions, I ſuppoſed a deep river; when it is not ſo every where, the fordable parts ſhould be obſtructed by every method that can be deviſed. If in either caſe there are but few acceſſible places, intrenchments muſt be raiſed on the bank before them, that the troops which march on the ſignal given, may enter them at their arrival.

Theſe intrenchments always uſeful, are oft abſolutely neceſſary; for if the enemy come with a conſiderable artillery at the ſame time with your troops, it is probable, that not being able to ſuſtain the enemy's fire without theſe intrenchments, they will be quickly obliged to quit the ſpot.

VII. There are ſo few ſchemes of this nature to quote, that it would be an affectation to paſs by thoſe *Folard* has propoſed on this ſubject, tho' the firſt does not appear clearly expreſſed.

" The beſt way, ſays he, is to make ſtrong epaule-
" ments, in the form of a creſcent or curve, at 80 or
" 100 fathoms from the place where it is thought the
" enemy can paſs; the 2 horns or extremities of the
" curve muſt be 20 fathoms from the ſide of the river,
" that they may not be enfiladed by the enemy's can-
" non, and that there may be room enough on the out-
" ſide to cover a great body of cavalry and infantry.
" This epaulement ſhould be 7 or 8 feet high, the
" earth caſt towards the enemy, as we make our
" trenches, and it muſt have a gentle ſlope; it is be-
" hind this little hillock of earth, covered from the
" fury of the enemy's cannon, that we wait at the paſs."

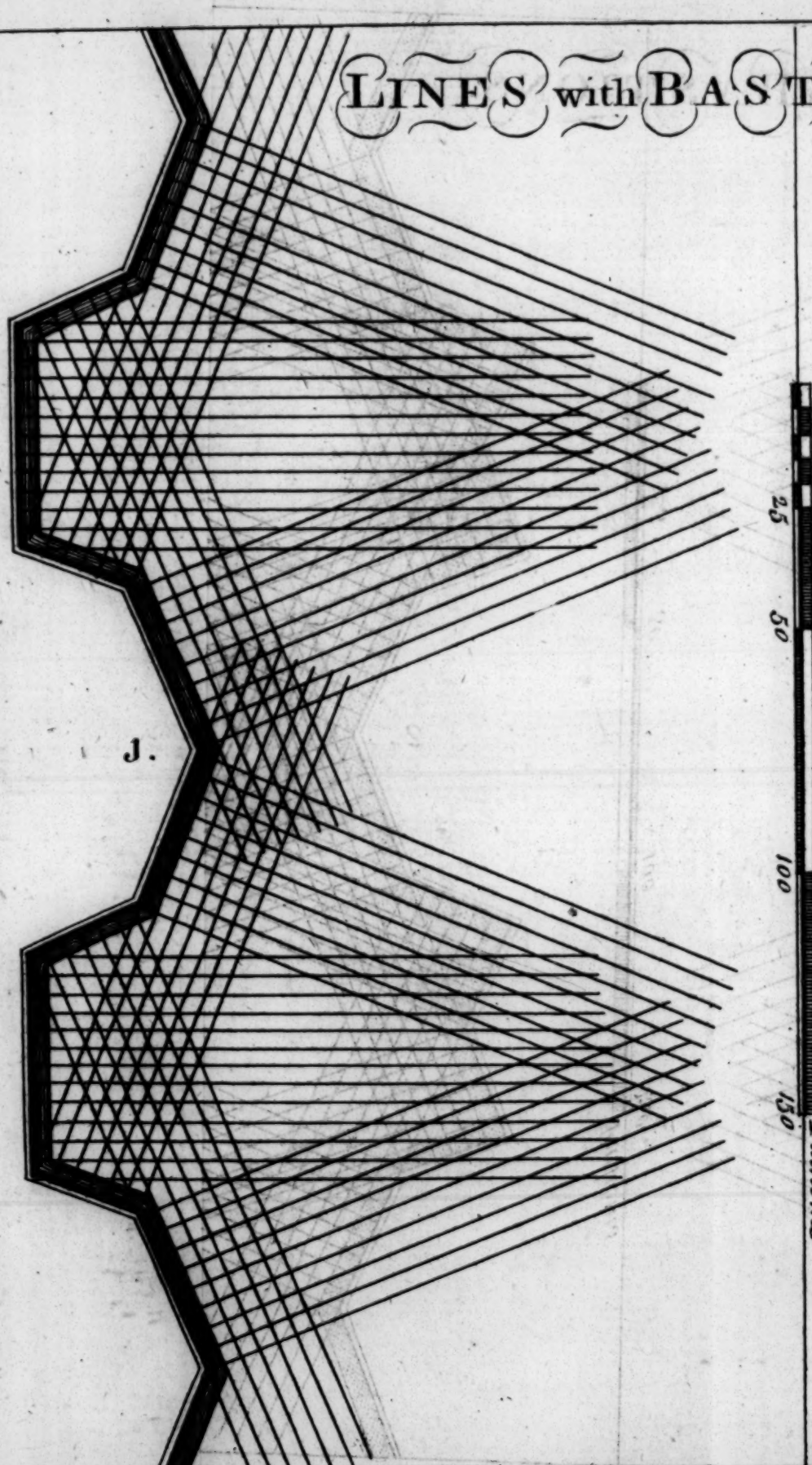
When a certain number of the enemy are paſſed, and begin to form in defiance of this croſs fire, which, as the author obſerves, will rake them in front and flank, " The cavalry mount their horſes, and march
" towards them, with a grenadier behind each, whom
" they ſet down, when within a certain diſtance, to
" form platoons of 50 grenadiers each, who are to en-
" gage them, between the ſquadrons."

This laſt paſſage is moſt unintelligible to me; it may be want of conception on my part; tho' it would not be aſtoniſhing, if in ſo great a work, wrote with ſo much ſpirit, an author full of his ſubject, ſhould not be equal throughout.

The figure ſo far from explaining, rather confuſes me the more, by the ſmall depth of the intrenchment,

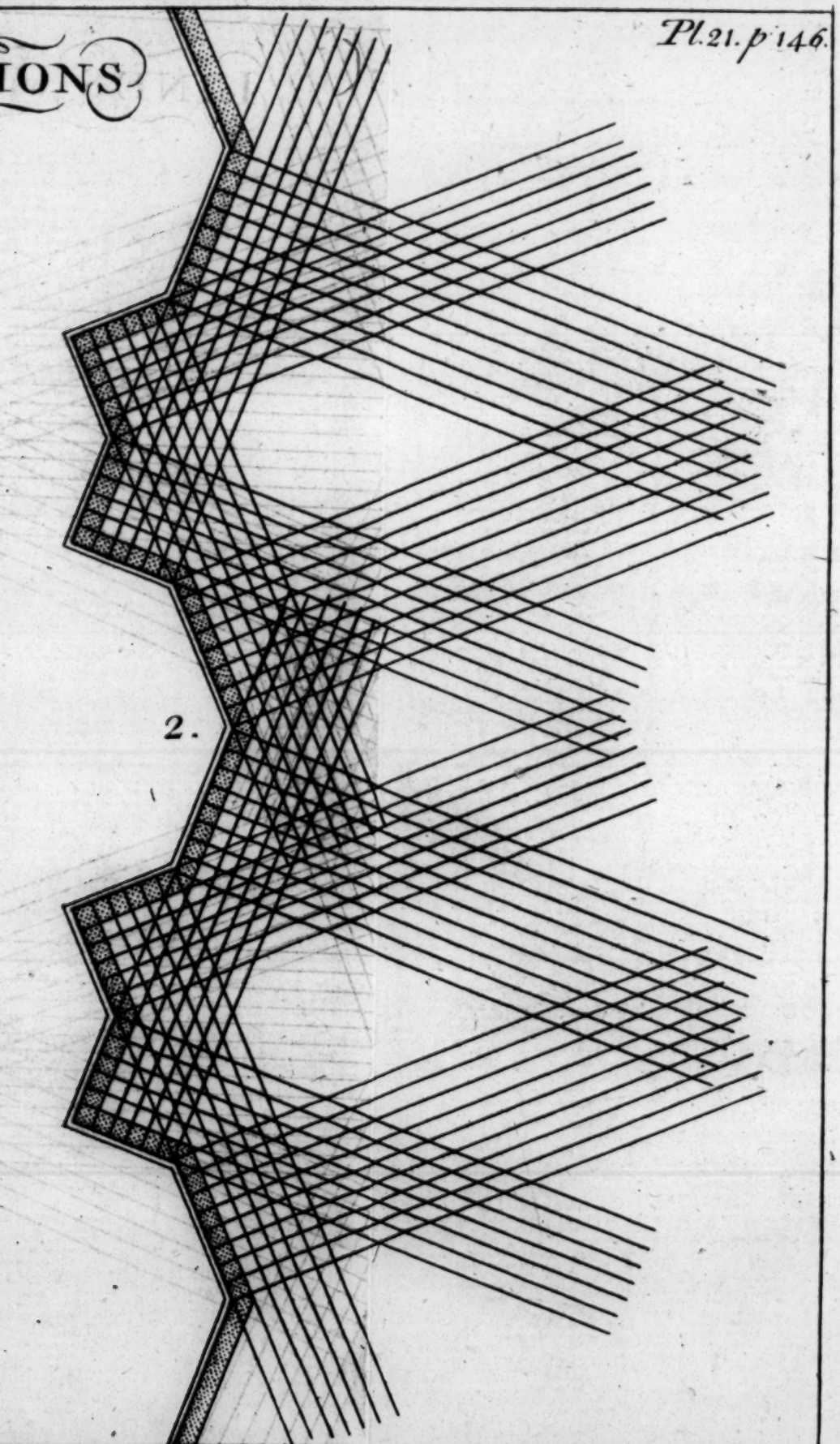
in

LINES with BASTIONS

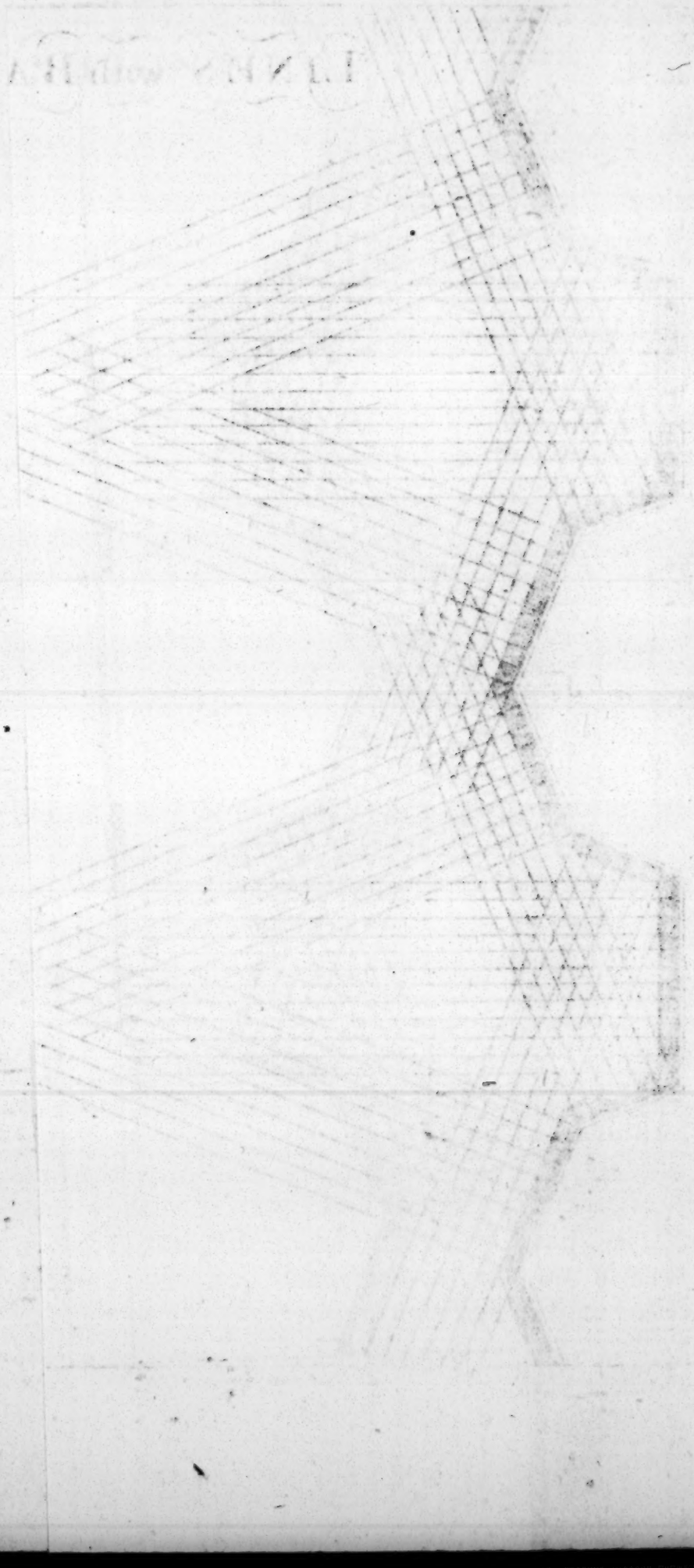


IONS

Pl. 21. p. 146.



2.



in reſpect to the number of troops drawn up there; were I not aſſured, that the ſame plate ſerves for 2 different examples.

VIII. The enſuing method I think anſwers *Folard*'s deſigns; the curve figure propoſed, tho' little practiſed, is convenient, yet requires choice and attention. The more the curve approaches to a ſtrait line, the eaſier it is to conform to an eſſential maxim of his, which is, that the exterior be covered throughout: beſides the order of battle will be leſs broke, the front of the troops which muſt line it approaching the nearer to a right line.

The elipſis muſt therefore be rejected, as having parts where the curve is too abrupt; and for a much better reaſon the ſemi-circle, which beſides that inconvenience, cannot be formed with a radius of 80 or 100 fathoms (the ſmalleſt range of a muſket) as the epaulement would not have extent enough.

The firſt ſcheme is conſtructed on theſe principles: it is the ſegment of a circle of 128 fathoms radius, and 80 fathoms for its verſed ſine, which determines the chord at little more than 226 fathoms. Pla. XXXI. Fig. 1.

This method is good, as the fires drawing nearer together, in proportion to the diſtance from the circumference, muſt have a great effect, as well on thoſe that have paſſed, as on thoſe that are paſſing; yet it is not eaſy in practice to trace the portions of ſo great a circle.

Thus the ſecond figure may be preferred: the opening is 240 fathoms; the middle line 60 fathoms long, parallel to the river, and 80 fathoms diſtant from it. Pla. XXXI. Fig. 2.

This line and thoſe of the ſides being ſtrait, the fires of each are parallel between themſelves, but they croſs a conſiderable ſpace (when thoſe of the firſt plan, in the ſegment of the circle, approach and unite) which may be thought more advantageous.

Pla. XXXI. Fig. 3. If that is not approved of, the circular form may be readily approached, by dividing the chord into as many parts as the figure is to have ſides, and determining the length of the perpendiculars either by computation or by the ſcale.

Which ever method is followed, the moſt eſſential point is to cover the exterior part of the work, ſo as not to be ſeen from the oppoſite ſide of the river, which will be at leaſt 400 fathoms diſtant from it, this is ſufficient in reſpect to the range of field pieces, and the uncertainty of firing at ſo great a diſtance.

This cannot be done but by epaulements, whoſe length will depend on the figure of the courſe of the river; if it forms a rentrant towards you, they will be ſhorter, if the elbow runs from you, they become larger, we here ſuppoſe the courſe in a right line.

Theſe epaulements muſt be ſo diſpoſed, that the troops may move eaſily behind the extremities of the work, that the files of troops be not ſquare with their front. It is on this maxim, that in the laſt plan I made them perpendicular to the ſides. The hook parallel to the river, alſo the adjacent parts on the right and left, are deſigned for artillery, which batters the acceſs and the paſſage of the river, and the enemy's cannon almoſt directly.

One obſervation remains on the profil of this work. Theſe gentle ſlopes, that the cavalry may aſcend and deſcend (which I believe is the author's meaning) would be very advantageous to draw out in line of battle; but their conſtruction will be found very difficult, if 7 feet and a half are given for the height of the epaulement, as they muſt have at leaſt 30 feet baſe, which added to the thickneſs at top, makes at leaſt 11 fathoms at the bottom, and 7 $\frac{1}{2}$ fathoms ſolidity in every fathom length; independent of this exceſſive work, it is evident what trouble there will be, in throwing the earth ſo far, eſpecially taking it only from one ſide, and how much the ditch adds to this diſtance and the length of the

the ſlope; it is alſo obvious, that the leaſt rain renders ſuch a paſſage abſolutely impracticable.

The whole is thus remedied; let the part of the epaulement deſtined for cavalry have only the natural ſlope, that is, a gradual one, with 1 or 2 openings of 36 feet each, and maſked at an equal or proportioned diſtance, which will ſerve as a paſſage.

The epaulement for the infantry 6 feet high, and its ſlope, 1 $\frac{1}{2}$ foot to a foot, that the battalions may leap over, without filing off.

In one caſe, there will be about $\frac{1}{2}$, and in the other $\frac{2}{3}$ leſs earth to remove, it is taken within and without, which greatly ſhortens the work, obſerving to make the excavation as broad as poſſible, that it may have the leſs depth.

The epaulements of the flanks will better guard againſt the ricochet, if we give them the height of the firſt profil, when the infantry are on the ſides. They cannot be leſs than 8 feet high to cover a man on horſeback, ſuppoſed on a level with the enemy, as I do here, and which certainly ſhould be taken as a rule.

IX. *Folard*'s other ſchemes relate to thoſe elbows, or turnings in a river, where the defendants cannot engage, without being taken, or battered in front, flank, and ſometimes in the rear. They certainly give the enemy great advantage; but to uſe the author's words, not ſo much as is imagined; for theſe windings are, at leaſt in part of their extent, enfiladed, and ſeen obliquely from the points where the curve begins.

To gain by this circumſtance, he raiſes a redout at each of theſe places, capable of containing 150 men with cannon; the reſt depends on the number of troops neceſſary to ſuſtain the poſt.

If there be a body of cavalry and infantry within reach, conſiderable enough to charge thoſe who may endeavour to force it, they are ſheltered from the enemy's cannon, by join- Plate XXXI. Fig. 3.

ing epaulements to theſe works, of the kind we have treated of, as it is pricked on the figure.

If there is only infantry, and the number of theſe windings does not permit to employ ſufficient forces at each, a line muſt be drawn from one redout to another, the middle of which is covered by a lunette, to which it communicates.

If the redouts can only be guarded, they muſt be ſo conſtructed, palliſaded, and defended, as at leaſt to hold out till ſuccours arrive; the ſame muſt be underſtood of the lunette and intrenchment.

I thought to flank theſe redouts, and to turn them and the line which joins them, in a manner moſt proper to have fulfilled their deſign; it is in that only, I here differ from *Folard*. We muſt obſerve, that in this, and the preceding article, he ſuppoſes the river fordable; if it was not, leſs work would ſuffice to hinder a bridge being thrown over. His epaulements are yet very proper for this uſe, ſince if the bridge was finiſhed, it would be uſeleſs, on account of the facility of ſucceſſively beating the troops that might endeavour to paſs.

Observations on the tenth Chapter.

The method of paſſing rivers, when an enemy is near, or preventing an enemy from paſſing, is certainly a maſter-piece in the art of war: what authors fully treat of and with the greateſt care, eſpecially *Folard*, in his commentaries upon *Polybius*, vol. 4. Our author, with infinite pains, explains it by the help of ſeveral draughts: the firſt plate 28, contains two bridge-heads joined by an indented retrenchment, wherein all the parts are well flanked; this example ſuppoſes an army to paſs a river, when the enemy is on the ſame ſide; and as a part paſſes, the others retire gradually from the retrenchment into the lunettes, which cover the bridges; and thoſe who have croſſed firſt intrench, to cover the retreat of the laſt.

The

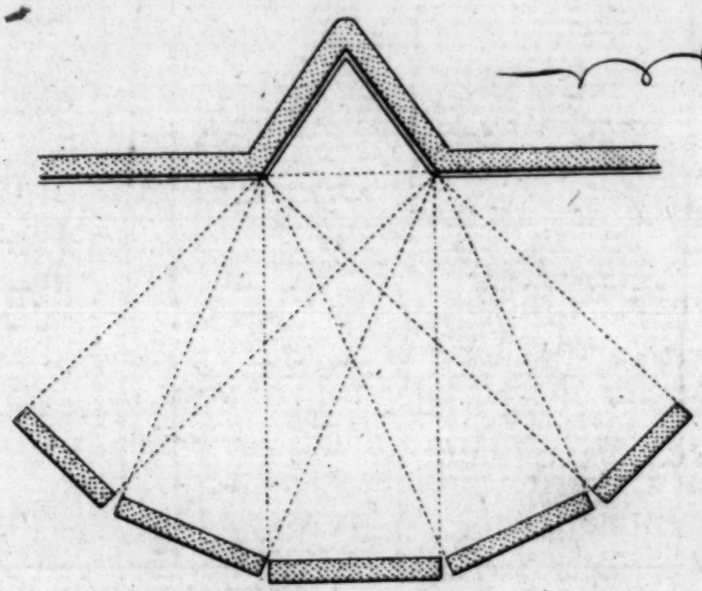
The example plate 29, ſuppoſes a large army, which is not only intrenched all round, but a part is cut off on each ſide by an indented retrenchment; that, when part of the army has croſſed, the reſt being inſufficient to line the whole work, may retire in the middle part; and as the number diminiſhes into that part between the bridge heads, and from thence into the lunettes which cover the bridges, whilſt thoſe on the oppoſite ſhore intrench to cover the retreat; to ſecure the retreat of the laſt, ſmall redouts are made with a double row of palliſades, within the lunettes, in each of which 2 companies of grenadiers are left; and ſo ſoon as the bridge is broke up retire in boats, which are partly towed over with ropes, and partly by rowing. It is evident, that this paſſage is as well covered as can be expected; and if the troops do their duty without confuſion, it will be a difficult matter for the enemy to break in upon them, tho' equal in number. Obſerve, that the ground muſt be level round this intrenchment for 7 or 800 fathoms diſtant; otherwiſe the enemy's cannon, placed on a riſing ground, would do great execution, and conſequently greatly diſturb the retreat; it would therefore be very hazardous to undertake the paſſage in that caſe; unleſs the cannon could be maſked by a high epaulement; or having a large battery on the oppoſite ſhore to oppoſe an equal or ſuperior fire to them.

The author's next example, relating to the retreat of the *French* over the *Rhine* in the face of the *Auſtrian* army, by prince *Conti*, is perhaps one of the fineſt ever made: as the author gives a very particular account of it, I ſhall paſs to the next repreſented plate 31, which he has taken from *Folard*'s notes upon *Polybius*; the queſtion is here to prevent an enemy from croſſing a river before your face, and with open force. The beſt way, ſays *Folard*, is to make a ſtrong epaulement in the form of a creſcent or curve line, at 80 or 100 fathoms from the place where the enemy is ſuſpected to

paſs, the ends ſhould terminate within 20 fathoms of the ſhore, ſo as not to be enfiladed by the enemy's cannon, and the intrenchment ſhould be large enough to cover a great body of horſe and foot: this epaulement ſhould be 7 or 8 feet high, and the earth thrown towards the enemy. This our author thinks is obſcurely expreſſed, eſpecially where *Folard* adds, when a certain number of the enemy have paſſed, and begin to form, the cavalry mount, and each takes a grenadier behind him, in order to form platoons between the horſe. What reaſon, ſays he, is there for mounting grenadiers for ſo ſmall a diſtance? If I do not miſtake, *Folard*'s reaſon was, that ſo ſoon as the enemy begins to form, no time ſhould be loſt, leaſt they may make too great reſiſtance when once formed; for which reaſon the horſe is to charge firſt, paſſing through the openings left near the ſhore, and which he expreſsly ſuppoſes not to be enfiladed; and as horſe alone is inſufficient to break the infantry, he makes each horſeman take a grenadier behind him, to form platoons, to aſſiſt the horſe till the infantry can come up and aſſiſt them; ſo that the obſcurity our author complains of, is not *Folard*'s.

He alſo complains that the retrenchment appears too ſmall for placing ſo many troops behind it; not conſidering it is done for a very eſſential reaſon, viz. to leave little ground for the enemy's forming in order of battle, and to defend the croſſing of the river more vigorouſly, both by ſmall arms and cannon; which could not be done ſo well at a greater diſtance than a 100 fathoms. Neither is there any want of room behind, for placing ſo many troops as is required; ſince under the cover of ſo high an epaulement, they may be drawn up in columns, as *Folard* would have them to fight; beſides, no ſpot of ground is every where on a level, and the leaſt bank or valley is ſufficient to cover more. It is evident, that the chief intent of this work is to defend the river at as near a diſtance as poſſible, and therefore any other poſition farther off would not anſwer

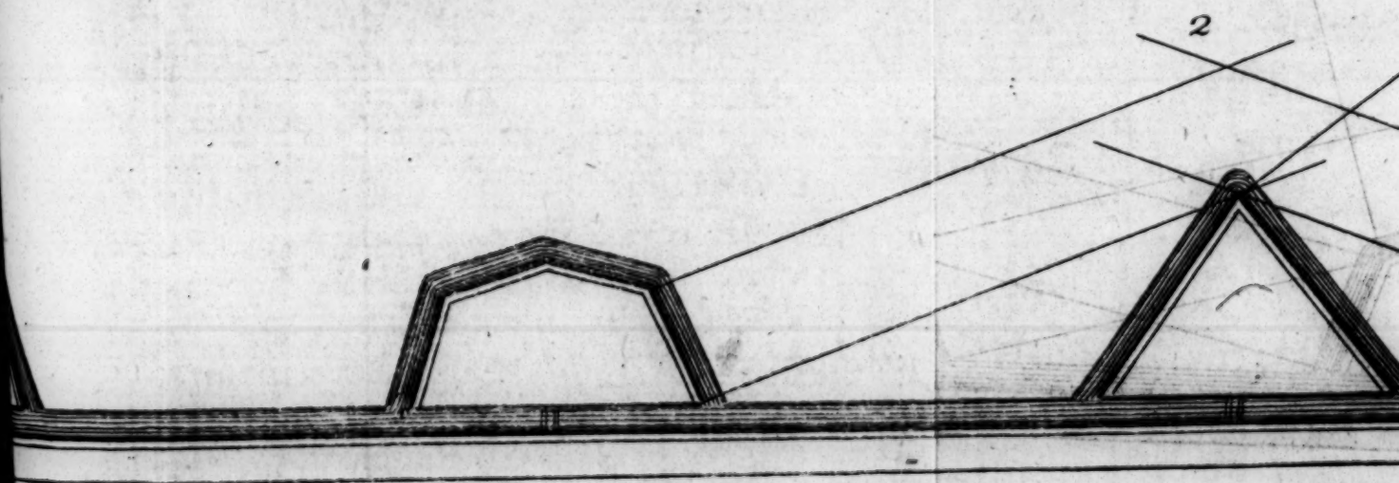
BASTIONS.



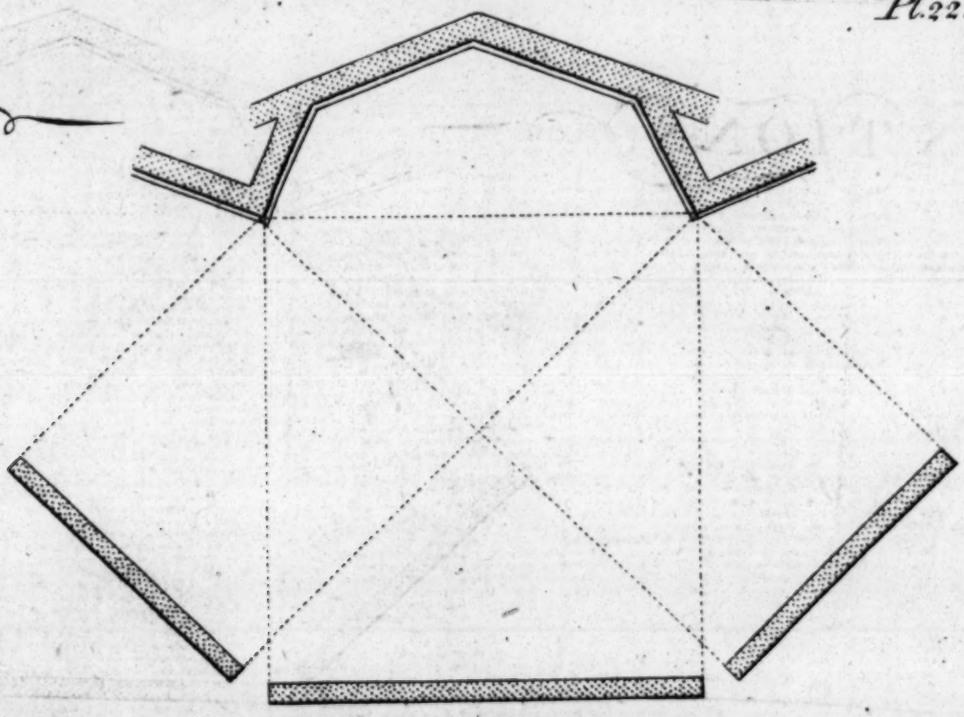
J

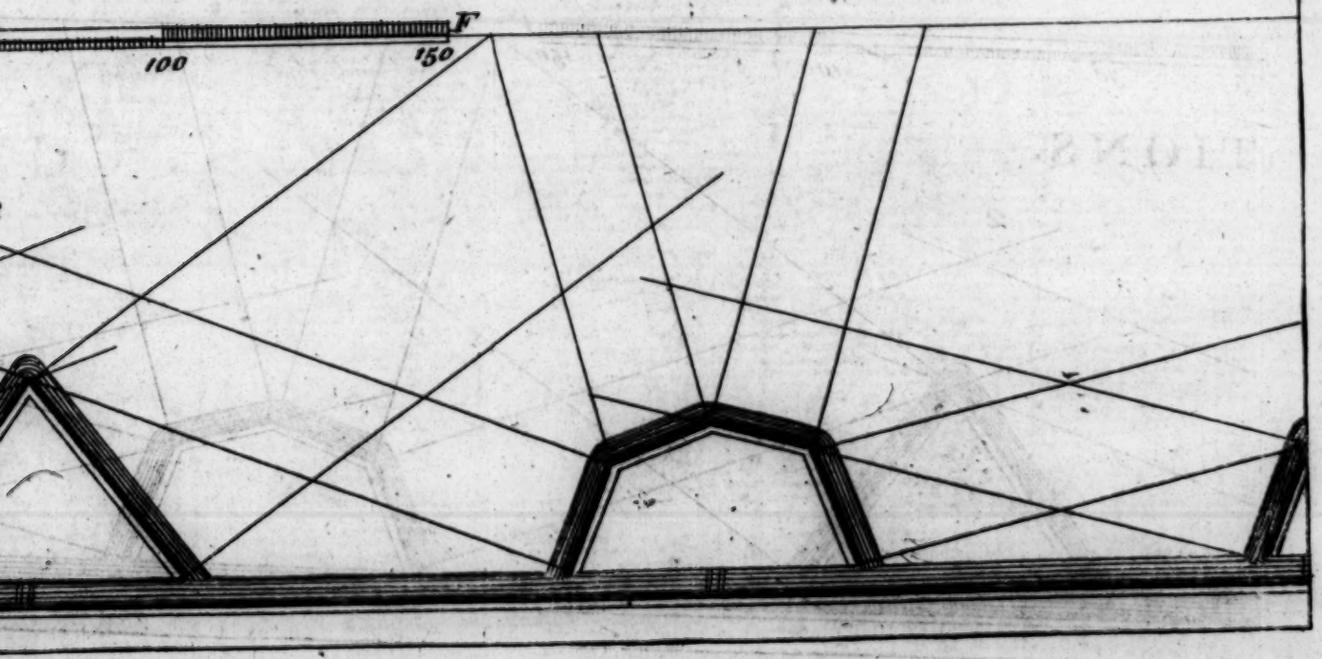
25 50 100

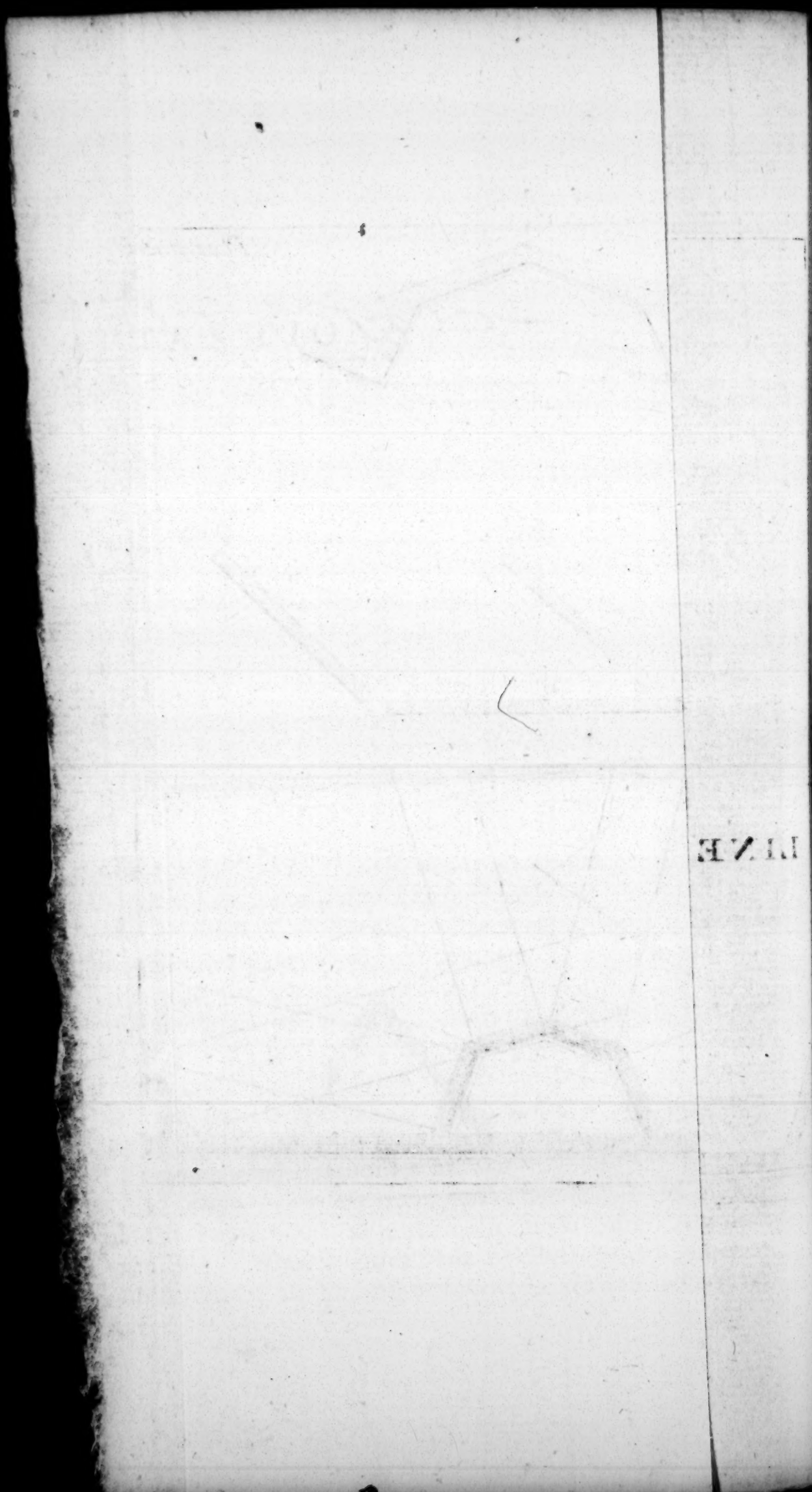
LINES with DETATCH'D BASTIONS



ONS.







ſwer the author's intention. The author makes a ſuppoſition, which reaſon ſhould have convinced him could not have been thought of; which is, that the eaſy ſlope made to the intrenchment was deſigned for horſe and foot to march over the retrenchment in order of battle. Upon this ſuppoſition he gives a long detail of the quantity of earth to be thrown up, and then ſays, that the leaſt rainy weather would ſoon waſh off the parapet. Another very uſeleſs inquiry is made, about the nature of the curve line, which is moſt proper for the retrenchment, he rejects the ellipſis, and the ſemicircle, and ſuppoſes it muſt be an arc only; but a circular arc of ſo great an extent being not eaſily traced, he makes them in parts of right lines joined. It is ſingular, that he ſhould imagine, that the curve muſt be geometrical: for in practice, works ſhould be traced without inſtruments at ſight; it is not material, if that curve may be quite regular, provided it anſwers the purpoſe; beſides, the nature of the ground may be ſuch, that a ſtrict regularity could not be obſerved, as to the works, which our author makes at the flanks, they may be very uſeful, if the enemy can flank the retrenchment.

He ſuppoſes, with *Folard*, that the inward bent of the river towards the enemy, is not ſo advantageous in paſſing as generally imagined. Whatever may be the opinion of authors, it may be aſſerted, that no better place can be fixed upon than that; for they pretend, that at the extremity of this bent their paſſage may be enfiladed, by redouts placed on the oppoſite ſhore; but will theſe redouts enfilade the bridge, where the river runs from the inward bent in a ſtrait line, as the author ſuppoſes in the third figure, plate 31? This may be the caſe of one in a thouſand, and therefore not to be mentioned; for example, ſuppoſe the ſituation was ſuch; what advantage can be taken? Theſe redouts, being cloſe to the ſhore, cannot the enemy erect a battery on the oppoſite ſide, of as many cannon

as

as he pleaſes, and ſoon deſtroy it; or at leaſt draw the fire towards this battery, and abandon the bridge? Unleſs it is ſuppoſed that the enemy has no guns, which is abſurd, and the objection frivolous.

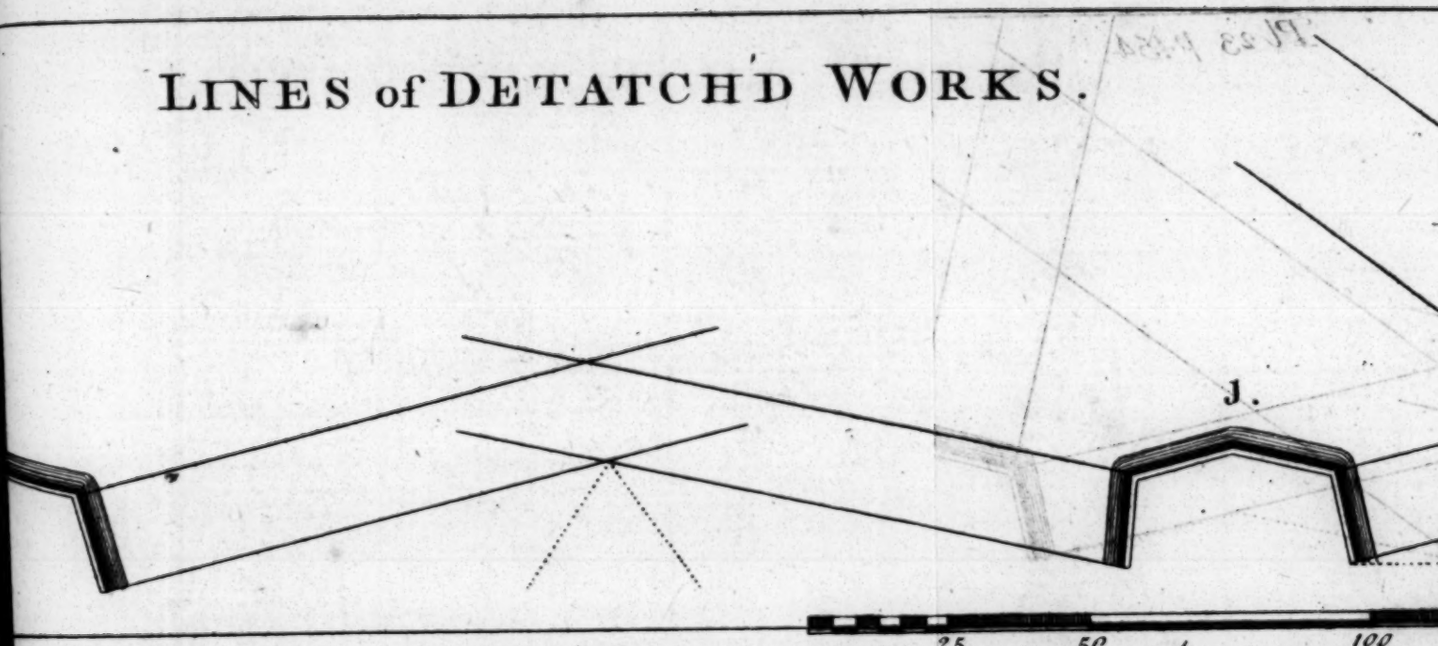
On the other hand, ſuppoſe the bent was from the enemy, would not the bridge, and all the works made to ſupport the paſſage, be enfiladed from every ſpot of ground on the other ſide? Would not then a general be blameable to attempt the paſſage of a river in ſuch a place? If the river was ſtrait, how would it be poſſible to defend the paſſage with any advantage, which the oppoſite army has not, even ſuppoſe a ſingle redan was made to cover the bridge, before any troops appear to oppoſe them? After as many troops are paſſed as the lunette can hold, how could they propoſe to march out upon a ſmall front, to receive an enemy, who is prepared to receive them, ſo ſoon as he arrives, before the batteries on the oppoſite ſhore can in that caſe fire upon the enemy without annoying their own troops.

The enemy may be deceived by feint marches, ſo far as to get to the place deſigned for the paſſage ſome hours before him; but ſo ſoon as he is come up, has it in his power to raiſe batteries for batteries, and thus fall upon thoſe that have paſſed firſt with all his force, without apprehenſion of the oppoſite guns.

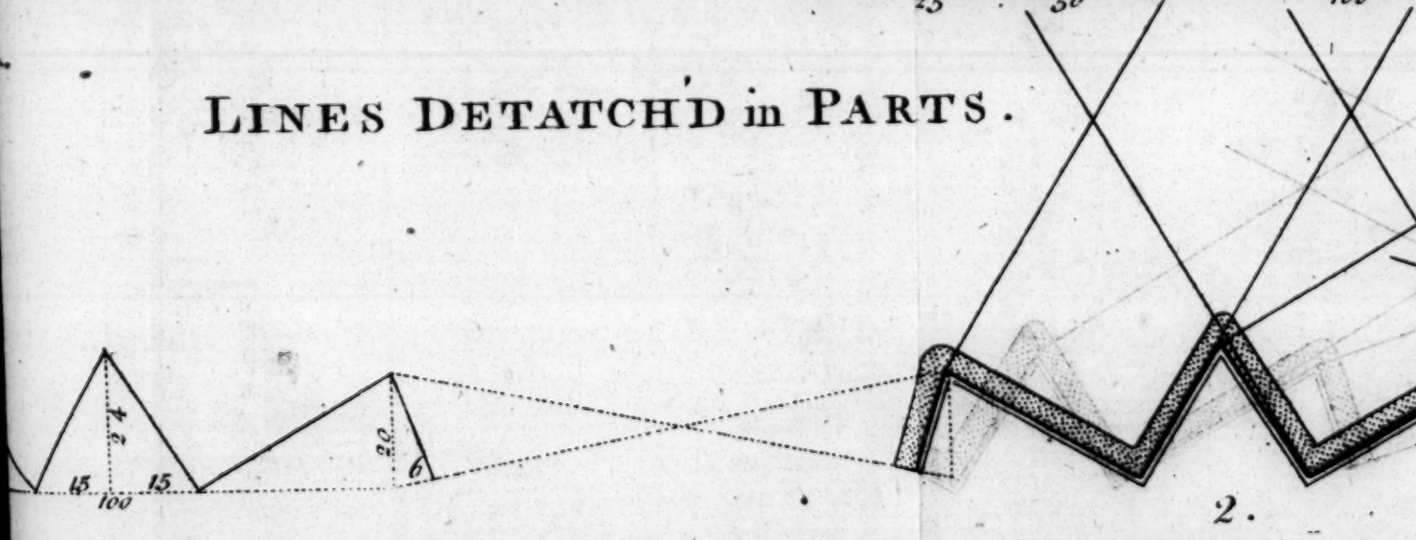
It may be aſcertained, that no better ſpot can be found for paſſing a river, either by force or ſtratagem, than at an inward bent of the river.

When the river may be forded in ſeveral diſtant places, *Folard* propoſes to deſtroy them, or render them uſeleſs, by felling trees on the oppoſite ſide, to make holes, ditches, inundations, or throw a great number of crows feet, or planks full of iron points, or, if poſſible, to throw a great many trees in them with their branches, to ſtop the current, and make the water ſwell, ſo as to render the paſſage impracticable without a bridge. Thoſe who wiſh to know more of this ſubject,

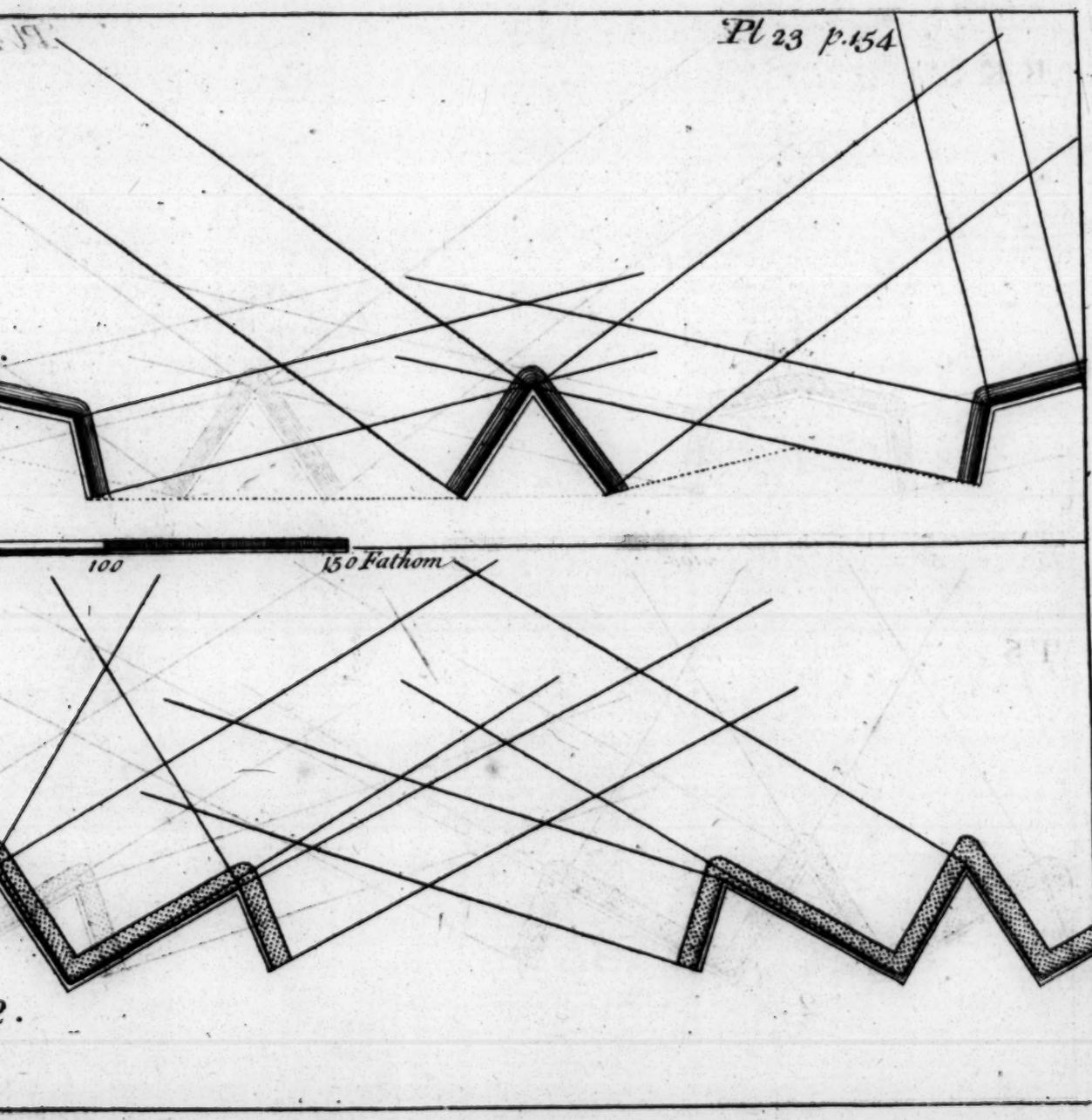
LINES of DETATCH'D WORKS.

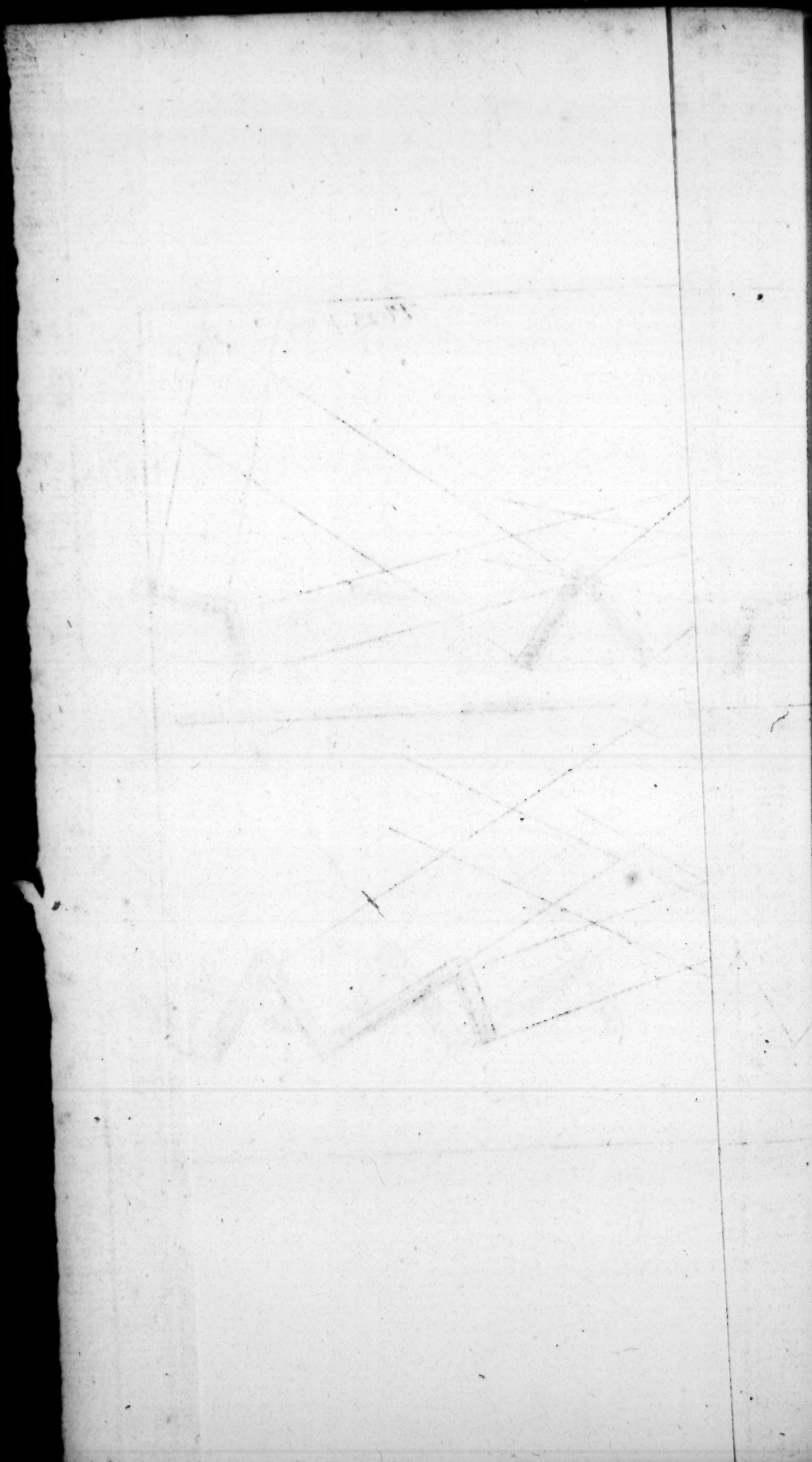


LINES DETATCH'D in PARTS.



Pl 23 p.154





ject, may conſult his fourth and fifth volumes upon *Polybius*.

CHAPTER THE ELEVENTH.

I. *Gates.* II. *Communications.* III. *Plat-forms.* IV. *Epaulements for cavalry.* V. *Schemes of intrenched epaulements.* VI. *Bog-houſes.* VII. *Forms of covering the gates of common lines.* VIII. *Covering thoſe of the different kinds of lines propoſed.* IX. *Advanced ditches; their advantages.* X. *Ravelins.*

I. I Shall comprehend under the name of lines all kinds of intrenchments that can be applied to them: lines have occaſion for certain works, ſome of which facilitate the neceſſary movements, others contribute to the ſecurity and convenience of the camp: ſuch are gates, interior communications, plat-forms for cannon, epaulements for cavalry, and bog-houſes.

The number of gates to be made in lines depends on the number of troops deſtined for their defence, the deſign of the general, and the nature of the adjacent ground.

There were but few gates in the lines of *Philipſbourg* in 1734, and they were no larger than thoſe in the places of arms of a covert-way. The reaſon was, I ſuppoſe, that our cavalry being ſent back for want of ſubſiſtence, to the other ſide the *Rhine*, weakened us greatly; and that we had a numerous army before us, that the taking of the place was our ſole object, as it was ſo immediately neceſſary, to prevent the overflowing of the water, which would have deprived us of all communication.

We may alſo uſe them for thoſe lines, which are only acceſſible by few roads, or for thoſe, before which there is not ground enough to draw up; theſe different caſes are exceptions to this rule.

We

We cannot in general have too many paſſages, as they are neceſſary in advancing or retreating; they are, as in chap. 5, the only means of abridging the time loſt in filing off, and conſequently of removing the defect *Feuquieres* has ſo juſty remarked.

Another important motive ſhould determine us to this; tho' the enemy, maſters of the parapet, leap over in ſome places, while the body of men at a diſtance advance to charge them, a ſally of ſome choice troops, made briſkly from right and left, and at a ſmall diſtance from the part attacked, is, as *Santa Cruz* and *Folard* remark, one of the beſt motions that can be made; but to do this the barriers, muſt not be too far diſtant from each other. *Vauban* in his attac of places, allows 22 feet for the width of theſe gates; he prefers the placing them in the high roads or in the middle of curtains, or near it, and covers them as ſhewn hereafter.

What he allows for lines of circumvallation, is equally proper for thoſe we are treating of; the paſſage is thus wide enough for the cavalry to file off by fours, and the infantry by eights. Certainly a beaten road is preferable to a new, and the paſſage cannot be better placed, than in the part beſt flanked.

II. One point this illuſtrious engineer inſiſts on, is that of a communication; there are few places that are not ſituated on rivers ſmall or large, which conſequently cuts the beſiegers lines into two. The kind of camps we are ſpeaking of, are not ſo frequent in this caſe, but it may happen; beſides, we commonly find rivulets, ditches, fenny grounds, hollow ways and thickets.

Every thing that may prevent the aſſiſtance, that one part ſhould give another, is ſo eſſential an inconvenience, that in the words of that author *, the ſafety of an army may depend on it; we cannot therefore be too attentive to this point.

* Memoire pour la conduite des ſieges. *Vauban.*

If the right is ſeparated from the left by a river*, he would have 3 or 4 bridges conſtructed, each 4 or 5 fathoms broad, and 50 or 60 fathoms diſtant from each other, to avoid confuſion, and their extremities defended and covered by redans.

This will be beſt done by boats, in regard to their length; if the bridges are on truſſes, which he prefers as being more firm, and leſs liable to diſorder, I think, according to *Folard*, it would be better that they were broad enough to paſs over by diviſions at leaſt; for, ſays he, "it does not acquire more time or trouble to "make one paſſage, or a bridge of 100, or 120 feet "broad, than ſeveral of 13, or 15." This is undeniable, and it is certain that more can paſs over one bridge of 120 feet broad at once, than over 4 of 30; as theſe narrow bridges often oblige the column to halt, while the head paſſes over: the more there are together, the ſtronger and in better condition they are to charge after their paſſage.

Which ever method we take, if the camp is cut by rivulets, ditches or hollow ways, we practiſe the ſame as for rivers, where we make ſlopes broad and gentle enough for cannon and cavalry to paſs eaſily: if any part is marſhy, cauſeways are formed of the ſame breadth as the bridges.

Buſhes, brambles and thickets, which may be found near the intrenchment at the rear of the camp, muſt be cut down cloſe, that the horſes may not ſtumble over their ſtumps; omitting nothing in ſo important an article, multiplying the bridges, and other means, in proportion as we can ſpare time and workmen.

III. Platforms for cannon are made at the ſame time with the line; generally in the moſt ſaliant parts, viz. in the flanked angles, where there is always more earth than neceſſary; by this poſition their fires croſs better, and extend farther.

* Traitè de l'attaque des places. *Vauban.*

Theſe

Theſe platforms are raiſed to 2 feet below the crown of the parapet; if the excavation of the rounding of the ditch does not furniſh earth enough to make them ſo large as neceſſary, and to form the ramps or ſlopes, the officer of the artillery, whom this particularly concerns, finiſhes them with his own men.

IV. *Vauban* mentions epaulements to cover cavalry, as a precaution neglected theſe 50 or 60 years; he does not ſay why the practice ceaſed, perhaps from the ſhort duration of moſt ſieges; whatever was the reaſon, as he propoſes them in countervallations, I may be permitted to give my opinion.

When we attac lines in broad day, we generally cannonade them for many hours, before we attempt to force them; then in whatever manner the infantry is diſpoſed, the parapet muſt be very low, and very bad, if it does not cover them and the cavalry (that is, the body which ſhould engage the laſt, and behind which the others ſhould rally in caſe of neceſſity) remains unneceſſarily expoſed to all the violence of this fire.

This expoſition, which I take to be juſt, diſcovers my ſentiments on this ſubject; we do not now practiſe theſe epaulements, is that a reaſon we ſhould not?

Tho' their utility appears evident, I do not pretend to ſay, they muſt be raiſed on all occaſions; for example, when we intrench in haſte, in the preſence of an enemy, we muſt not do by halves what is abſolutely neceſſary, and loſe time, in what may only be uſeful by chance: beſides, will it not be the heighth of imprudence to fatigue the men too much, who muſt engage a few hours after? So far from that, I would have theſe epaulements made only in thoſe lines, conſtructed at leiſure, which may be of uſe ſo long as the war laſts.

There is alſo ſome eſſential circumſtances to be obſerved in placing theſe works. "We raiſe them, ſays "*Vauban*, principally in the parts commanded from "without, ſeldom in any others." It is certain, that they are moſt wanted there, but they will be very uſeful

ful in level ground, eſpecially if the intrenchment is weak; but if the parapet of the line, by its profil or poſition, will cover the cavalry, or if the ground on which they are drawn up is ſo low, that they cannot be ſeen over the parapet, then ſuch a precaution may be ridiculed, as the line itſelf ſerves inſtead of it, though always leſs perfect, becauſe the troops, at a diſtance from the parapet, are moſt expoſed to the enemy's ſhot.

Theſe epaulements, generally made in the moſt open places, have one more advantage (ſuppoſing cavalry in proportion) which is that of covering the front, and ſometimes the rear of the camp.

I never ſaw them but at the lines of the *Loutre*, between *Wiſſembourg* and *Alſtatt*, but they were half in ruins: M. *Vauban* placed them at an equal diſtance from the line and the head of the camp, parallel to them: he made them about 40 fathoms long, 9 or 10 feet thick, and as high; and 50 or 60 fathoms interval between each.

V. It is common with the more northern nations, to place platoons of infantry between the ſquadrons: this precaution, ſo well known to *Montecuculli*, and ſo much recommended by *Folard*, has oft ſucceeded with the *Swedes* againſt the *Germans*, and with the *Germans* againſt the *Turks*, Such a fire, always very briſk, and better directed than that of carabines, is very proper to protect the motions of the cavalry; may it not then be here as advantageous, at leaſt in certain caſes?

The cavalry of the line being repulſed and half broke, I would have them rally behind theſe epaulements; and to give them time and means to do it, there ſhould be a ſudden and ſmart fire, that they may not be followed too cloſe.

A ſcheme I propoſed in 1735, for raiſing a battery at *Philipſbourg* to defend our forage, appears to me perfectly convenient here. We may form the common epaulement, only obſerving to make a banquet in its ditch, and to raiſe

Plate XXXII. Fig. 2.

its

its counterſcarp like a flat parapet, about 2 feet high, that the fire may be better directed.

It is obvious, this will not occaſion any increaſe of labour; an epaulement thus lined, with 50 or 100 ſoldiers, firing nearly level with the ground, would be very terrible, and prove a great ſupport to a diſordered troop. This conſtruction has yet this advantage, that if circumſtances do not permit it to be uſed, no inconvenience follows.

In places level, but of ſmall extent in proportion to the number of infantry to be diſpoſed of, a banquet may alſo be made behind the epaulement, and the uſual ſlope given to the parapet: 2 lines of fire thus diſpoſed, muſt probably have a great effect, as the depth of the ditch, and the ſlope of the upper banquet equally protects the ſoldiers above and below, from the approach of the enemy's cavalry.

Plate XXXII. Fig. 3.

The crotchets, as in the plan, alſo ſeem neceſſary to cover them from oblique fires; they form little flanks from one epaulement to another, and even cover each other if the enemy come on the flanks; in this caſe alſo, the 2 ends of the ditch, formed like the reſt of the parapet, will greatly ſtrengthen this defence.

VI. I ſhall mention the inconveniencies of boghouſes; wherever they are placed in the lines, they are always troubleſome; if without, they facilitate deſertion; if within, they are a nuiſance, and ſometimes break the line of battle.

VII. Unleſs we cover the gates, it is evident that the enemy's cannon will break the barriers, and firing thro', will batter one part of the camp, in proportion to its ſituation and the breadth of the openings.

The cuſtom in common lines is to cover them with detached redans in form of ravelins. *Vauban* makes the capital 22 fathoms, and the faces 28: the gorge is thus 34 fathoms, 3 feet 10 inches; which, not agreeing with the ſides

Plate XXXIII. Fig. 1.

ſides of the figure in the book, proves there is ſome miſtake in the numbers.

He forms the flanks by taking 10 fathoms from the face, and 5 from the gorge, but making thus an angle of 98°, 35,′ 30,″ only with the counterſcarp, all the fire is directed towards the next redan, which gives room to ſuppoſe, that the principal deſign of theſe flanks, uſeleſs in themſelves, is (by ſhortening the faces) to give more effect to the fire of the curtain, of which they yet maſk near 25 fathoms.

The ditch of theſe works, parallel to the faces, muſt be produced to that of the line, that it may be commanded throughout: by this we muſt raiſe a great quantity of troubleſome earth.

Beſides, theſe ravelins produce a very good effect: the fire of their faces, croſſes near the capital of the redans, which, as already obſerved, want this aſſiſtance; and it perfectly covers the gate and the bridge. A material advantage in the ravelins of places, which oft are abandoned for want of a communication.

Nothing more need be obſerved on this head, except, that ſuppoſig the counterſcarp 3 fathoms from the parapet, as one of the lines of fire of the redan will paſs at leaſt 6 fathoms from the point of the ravelin, we cannot diminiſh the front of the line more than 15 or 16 fathoms; if, for example, it was reduced to 100 fathoms, this point would be battered.

VIII. A few words added to the inſpection of the plans, will ſhew my method of covering the gates of the different kinds of lines propoſed. For thoſe with redans, where the barriers cannot be better placed than in the ſaliant of the curtain, maſk them with a lunette of 16 fathoms capital, reckoning from angle to angle: make the faces 20 fathoms long, drawing them to the rentrant of the redans, and the fire, ſuppoſed perpendicular, will graze without battering them; I here mean the 2d ſcheme of 150 fathoms front, on that account preferable to the other. The extremities of the ditch of this little work,

Plate XXXIII. Fig. 2.

if not full of water, muſt be ſloped in a glacis reverſed, that the enemy may not find any ſhelter.

Plate XXXIII. Fig. 3. A lunette of 20 fathoms capital, and 15 demi-gorge, placed at the rentrant of lines, with tenailles, will cover their barrier.

Plate XXXIII. Fig. 4. That of indented lines, are maſked by a reduit, formed on one ſide by the prolongation of the branch, and the other paralled to the crotchet.

Plate XX. Fig. 3, 4. The excavation of the branches of the communication, viz. the part of the branches between the traverſe and the ditch, ſerve for covering the barrier of the 2 kinds of lines with lunettes, and thus ſave ſo much work.

The baſtion lines in this reſpect are much more difficult than the reſt, and unfortunately I cannot quote thoſe of *Philipsbourg*, for their barriers were not covered. The difficulty ariſes, by ſuppoſing, as I have done throughout, the ſmall arms to fire at right angles; ravelins cannot well be uſed, for if they are only ſeparated from the faces of the baſtion, by the breadth of the ditch, they maſk almoſt all the fire of the flanks, as already obſerved; and if they are as far from the faces as ſhould be, that is, the length of the flanks, we not only run the riſk of having theſe pieces flanked, and taken in rear, by the gorge, but the communication would not be ſo ſecure, and the barrier would even be ſeen obliquely from the extremities of the ſhoulder.

I have given here 2 methods to avoid theſe inconveniencies, the reader may decide which merits preference.

Plate XXXIV. Fig. 1. The firſt is, to make a *Fauſsbray* before the curtain: 12 fathoms broad from the parapet that carriages may paſs eaſily, and that they may be flanked by the baſtion.

Plate XXXIV. Fig. 2. The 2d is a little more compounded; draw a line from the ſhoulder of one baſtion

on to that of the next; divide this line into 2, and from the middle let fall a perpendicular inwards, equal to half this line, its extremity will be the point of the angle of a redan reverſed, whoſe branches are drawn from that point to the ſhoulders of the baſtion. The curtain being thus broke a 2d time, raiſe a parapet on the firſt tracing, and it will ſhew the figure.

This rentrant angle being right, and its branches grazing the ſhoulders, their fire, tho' leſs advanced than they were, paſs beyond the capitals of the baſtions, and cut them, which muſt be an advantage. Detached baſtions are neceſſary to cover gates, and the lines with detached works, or thoſe detached in parts, having no occaſion for theſe additional works, I have nothing more to add to this article.

IX. In my maxims, I ſaid we might, without danger, even in dry ground, cover every flanked work with an advanced ditch, provided the flanks were not too oblique, and ſufficiently ſaliant explanation.

An advanced ditch will be always uſeful, and ceaſe to be dangerous, when ſeen and battered throughout its extent; the enemy will not then find that cover, which have made the greateſt maſters reject them; in ſhort, the enemy will be as much expoſed there, as on the counterſcarp.

To effect this, *1ſt*, the advanced ditch muſt be enfiladed at right angles, or at leaſt under an angle from 90 to 100 degrees, with the flanks of the line: *2dly*, its diſtance from the ditch muſt be ſuch, that its counterſcarp does not project beyond the interior angle of the ſhoulder, that the whole ditch may be under the fire of ſome part of the flank: *3dly*, that at the rentrants the advanced ditch be produced, and cut down in form of a glacis reverſed, ſo as to leave no cover, as already ſhewn.

Theſe circumſtances, which remove all difficulties, are eaſily to be obſerved, in moſt parts of the works I have propoſed. I will give 2 examples. In lines with

Plate XXXIV. Fig. 3.

redans, trace the advanced ditch parallel to the ditch, becauſe the angle of the flank with the branch is only 99°, 34′ which is not too much; and if I had made it ſquare with the line, it would have thrown me more than 16 fathoms towards the country oppoſite to the break, and in proportion oppoſite to the point of the redan.

Plate XXXIV. Fig. 4.

In broken lines with tenailles, which I here ſuppoſe with lunettes, I do not follow the parapet, which lengthens the ditch to no purpoſe, and which would alſo be much leſs defended; but it is parallel to the principal lines of defence, and conſequently ſquares upon the flanks. If to this we add the neceſſary ſlopes, it muſt be confeſſed that this piece of fortification, far from being dangerous, becomes uſeful even in dry ground.

Its chief advantages are, 1*ſt*, that if the ſlope is the leaſt ſteep, the firſt rank of the aſſailants, embarraſſed with their faſcines, throw them in here to leap over, ſo that they have them not to fill up the ditch of the intrenchment. 2*dly*, That far from ſerving the enemy as a place of arms, to take breadth in, and there oppoſe the line with ſmall arms, as they will find no cover there, they will quickly leap out of it, and conſequently in diſorder.

Theſe obſtacles become almoſt inſurmountable, if we have time to dig pits between the ditches: nothing is better to diſconcert an enemy in an attac, or more difficult to fill up. With this view, viz. that the enemy may not know where to tread, that in the firſt figure, and at the ſaliant of the 2d, I have only left about 4 fathoms diſtance, from one ditch to another, that 3 rows of theſe pits placed alternately may ſuffice.

The earth of theſe wells is thrown up in ſmall heaps in their intervals; that of the advanced ditch, whoſe contents is leſs conſiderable, may be thrown in form of a glacis on its counterſcarp.

X. New advantages may reſult from advanced ditches, when judged neceſſary: viz. That of conſtructing ravelins before the curtains of baſtioned fronts, without falling into the inconveniencies mentioned in the 8th article of this chapter.

It is evident, that thus we are free from the danger of being taken by the gorge, without being obliged to maſk part of the fire of the flanks: this is an eſſential point, yet as there muſt be a gate in the line, to communicate with this detached work, and we muſt as much as poſſible hide this gate from the enemy, other meaſures muſt be taken.

We ſhall fulfil this point only in proportion as we diminiſh the diſtance of the ditches: therefore we muſt particularly obſerve. That the fire of the flank only beginning from the interior angle of the ſhoulder, we may without danger from thence draw the demi-gorge of the ravelins, which will thus leſſen its diſtance from the parapet: we do not gain much by this, but we ſhould much more, if we placed 2 pieces of cannon in that part of the flank next the ſhoulder, which if charged with grape, and pointed between the 2 ditches, at the time of the aſſault, muſt do great execution. Beſides, as the diſtances is ſmall, theſe pieces may be moved from the flanks to the faces, having but 1 to remove entirely.

We may then without inconvenience draw the demi-gorge of the ravelin, and the counterſcarp of the advanced ditch, 5 fathoms from the angle of the ſhoulder, taken externally, ſo that drawing the faces of the ravelin on the faces, at the like diſtance from the angles, the barrier, and alſo the communication will be pretty well covered.

This ravelin is traced according to the common method, viz. taking the diſtance of the 2 points; where the faces of the ravelin fall upon the faces of the baſtions, as a baſe, and conſtructing two triangles thereon, 1 a rectangular, and

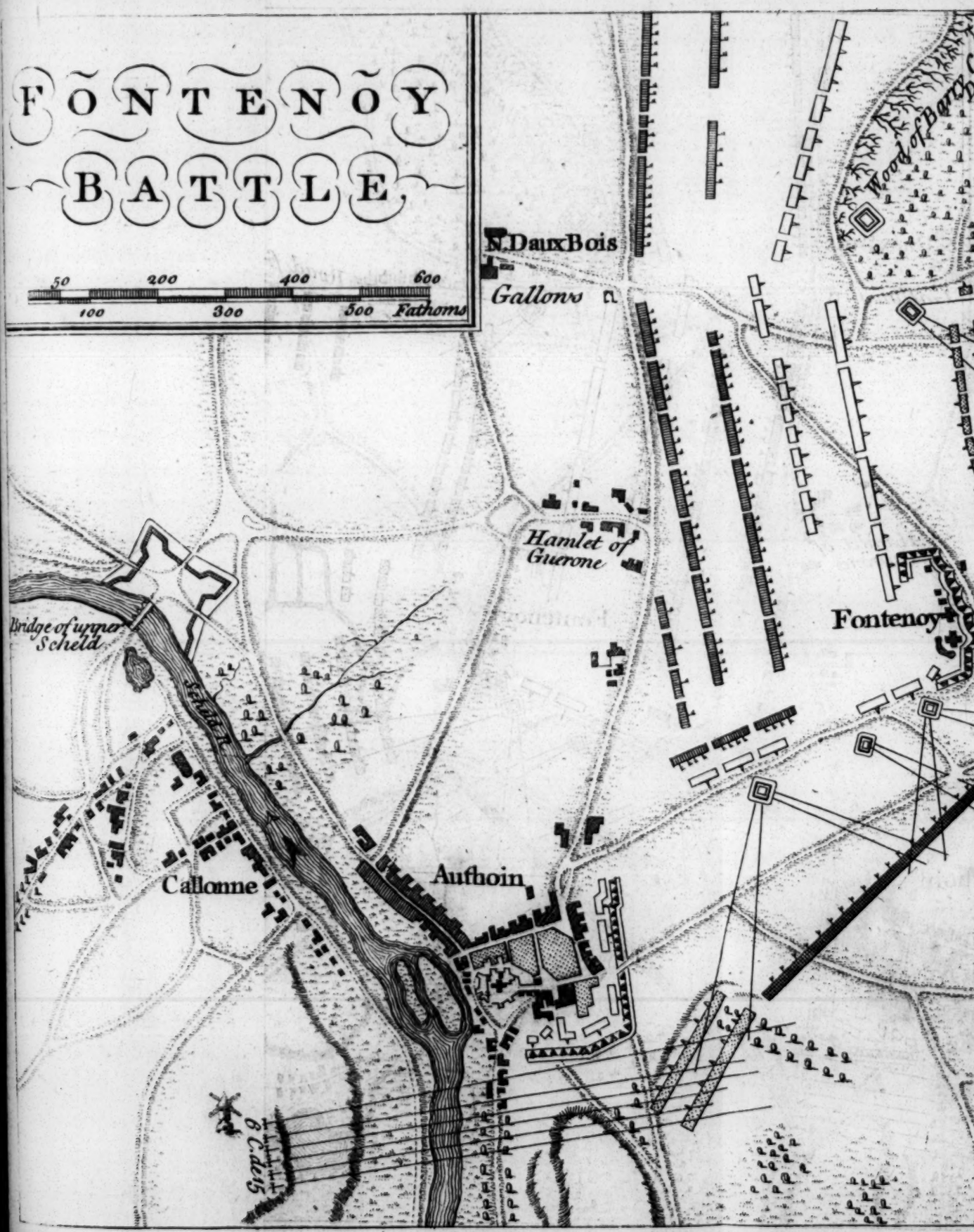
Plate XXXIV. Fig. 5.

and the other an equilateral, and dividing the diſtance of their ſummits into 2, that point will be the point of the ſaliant angle of the ravelin.

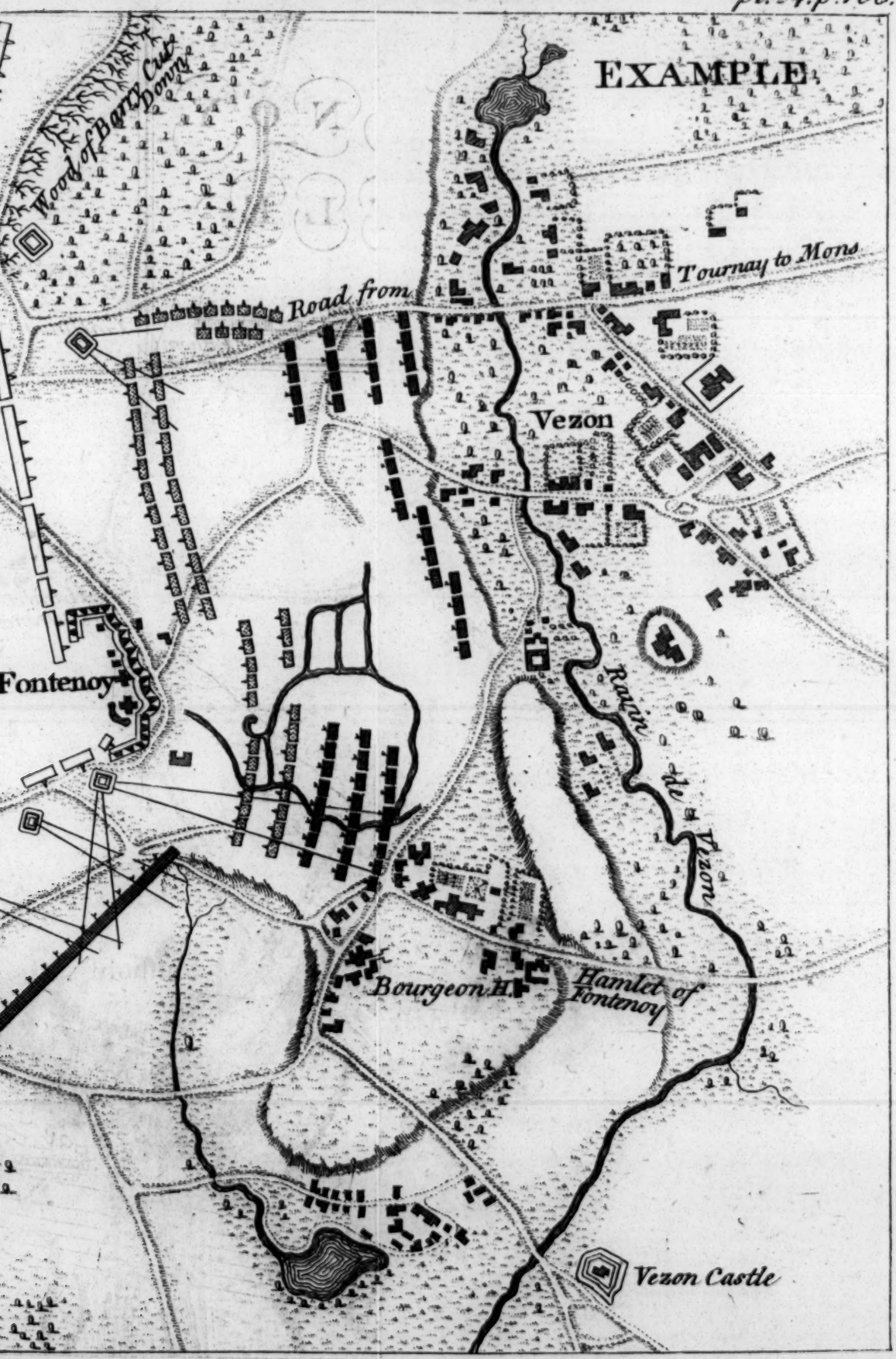
Theſe pieces, tho' low and weak, cauſe a great increaſe of work, and I own, as in chap. 5, that I do not approve of detached works in field fortifications, eſpecially when we have not means and time to render them capable of reſiſting an aſſault. We ſhould then only make ravelins to intrenchments of ſmall extent, and made with great care; ſuch, for example, as intrenched camps, eſpecially when they can only be attacked in one part, as thoſe of *Ruſſenheim* and *Spire*.

Observations on the eleventh Chapter.

Little can be added to what the author ſays, concerning barriers and their coverings. I ſhall only obſerve, that in baſtioned lines, as repreſented in fig. 1, 2, plate 34; the coverings contain more work than neceſſary; ſince a traverſe behind the curtain, of a little more length than the width of the barrier, will be ſufficient to prevent the enemy's cannon from moleſting the troops in the line. The ravelin in fig. 5, ſeems too large, and may be much leſs, without loſing the advantages the author propoſes by its conſtruction. For if the counterſcarp of the 2d ditch, which terminates the gorge of the ravelin, was to meet the inner angles of the ſhoulders, as alſo the faces of the ravelin, both being produced, it would be ſufficient; I would prefer the making the paſſages out of the ravelins, at the extremities of the faces, and not in the middle; as they would in that caſe be defended by the fire, from the oppoſite flank directly, and by the oppoſite face in flanks, all that can be done or deſired; and the fire of the flanks would then not be maſked by any part of the ravelin.


FONTENOY
BATTLE
50 200 400 600
100 300 500 Fathoms
N. Daux Bois
Gallons
Wood of Barry
Hamlet of Guerone
Fontenoy
Bridge of upper Scheld
Scheld R.
Callonne
Aufhoin
C. des
Redoubt

pl. 24. p. 166.


EXAMPLE
Wood of Barry Cut Down
Road from Tournay to Mons
Vezon
Fontenoy
Ravin de Vezon
Bourgeon H.
Hamlet of Fontenoy
Vezon Castle

CHAPTER THE TWELFTH.

I. *Irregular fortifications: maxims.* II. *Rentrant angles.* III. *Saliant angles.* IV. *Method of occupying heights, of preventing their being enfiladed, and tracing works on their deſcent.* V. *Reflections on heights.* VI. *Villages and buildings within reach of the work.* VII. *Caſe where detached works are neceſſary.* VIII. *Woods.* IX. *Moraſſes, hollows, hollow roads, hedges, rivulets.* X. *Manner of proportioning to the ground, the lengths of the fronts of the propoſed method.*

I. I Have hitherto ſuppoſed the intrenchments raiſed on level ground, and the lines ſo uniform, that all the tenailles were equally diſpoſed, and on the ſame line; the works I have ſuppoſed quite regular. I thus purſued the method taken in treating of the fortification of places, and with the ſame intention, viz. to form the ſubject, by eſtabliſhing general methods, to follow as much as poſſible in the execution; for ground is ſeldom found ſo uniform, but that the regularity is at leaſt as difficult to be obſerved in one caſe, as in the other.

We ſhould leſs regard what has been ſaid on this ſubject as poſitive precepts, than as general notions, proper to multiply and rectify the particular ideas, which circumſtances require in practice. The engineer muſt know how to act, according to circumſtances, and it is advantageous to have many different methods to compare, and follow that which appears beſt.

We ſhall ſoon find how much is to be expected from theory; the irregularities of the ground and other circumſtances, vary ſo much, that all that can be added to what has been already treated of, is to ſhew how to take certain advantages, and avoid, and ſurmount ſome foreſeen difficulties, generally very common.

I ſhall give few maxims on this ſubject; but they are as important as extenſive: one, that all parts be as much as poſſible, ſo equally capable of reſiſtance, that one part need not be feared more than another; in this reſpect we muſt regard the advantages of the ground: the other, to have as much attention, to gain by every thing that may be favourable, as to avoid what may be hurtful.

II. A turning, a winding, a projection in the lines may be deemed an irregularity, but that is almoſt always unavoidable. If the angle it forms be a rentrant, it ſometimes encreaſes the defence; if a ſaliant, the contrary. Rentring angles, right or obtuſe, and thoſe which are acute are oft fortified after different plans. A rentring from 90 to 120 degrees, though the defence be very oblique, forms a tenaille, and conſequently flanks itſelf, provided its branches, being of a due length, are ſhortened by degrees, as it is more open; ſo that at 90 degrees they have but 80 fathoms, at 100 degrees 70 fathoms; 110 degrees 60 fathoms, and at 120 degrees but 50 fathoms.

Plate XXXV. Fig. 1, 2, 3, 4.

This ſhortening is neceſſary, that one part of the fires may croſs the capitals, which could not be without that; for they fly off from the ſaliants, in proportion as the angle is obtuſe. I do not give this as a geometrical rule, it will only ſerve in practice, and ſufficient in common caſes; for if the ground on the right and left is not on the ſame line, we muſt have regard to the difference the inclination of theſe new angles gives to the capital. The figure will explain what I mean, and ſhew that the ſaliant on one ſide, though double in length to the other, can be better defended.

Plate XXXV. Fig. 5.

When the branches are too long, or the angle very open, ſome indented work will immediately remedy all, as it not only forms new flanks, but alſo diminiſhes the opening.

Plate XXXV. Fig. 6.

As

As to rentrants under 90 degrees, they are fortified according to the breadth of their opening: if it is only 120 fathoms, it will ſuffice, as an enemy would be thereby engaged between 2 fires. A ſimple parapet in a right line, always neceſſary to cover the communication, and prevent the camp from being battered obliquely, ſeems ſufficient; yet as the enemy may throw themſelves all on one ſide, or attac both at once, it is neceſſary, that the anterior parts be flanked, and the branches ſo diſpoſed, at leaſt for a certain depth, that they may be uſed without firing on each other.

On this occaſion I ſhall again venture my thoughts, in giving a ſcheme for an opening of about 200 fathoms: in the treatiſe of the attac of places we find one of theſe rentrants fortified to the very bottom by indented works; if we reflect that branches with more than 200 fathoms interval, exceed the range of a muſket, it muſt be allowed as this is a different caſe, I cannot perſue this example without breaking thro' the rules. Plate XXXV. Fig. 7.

III. *Vauban* in this, as in his ſiege of *Aeth*, gives ſome ſaliant angles, all fortified; the moſt open by baſtions, the others of 90 degrees at leaſt by demi-baſtions, and by the intrenched camp at *Dunkirk* it appears, that when they were acute he cut them to make tenailles.

We are ſeldom obliged to make theſe laſt angles; yet as we may have occaſion to poſſeſs a point of land, I will ſhew in general how I would flank all from 60 degrees to the greateſt opening.

The angle of 60 degrees, being the moſt acute that can be admitted in fortification, muſt not be diminiſhed: its flanks muſt conſequently be taken externally; the beſt for this purpoſe, as being the leaſt ſaliant, are indented crotchets, which may ſerve for all others. Plate XXXV. Fig. 8.

As the right angle has 30 degrees more, it may be defended different ways; I would Plate XXXV. Fig. 9.

prefer

prefer the preceding, taking the crotchet within, if poſſible, for it will be yet 61 deg. 56 min. If a demi-baſtion is thought beſt, care muſt be taken that the face be defended, and that no part in the front fires on another; independant of the irregularity, it appears to me that we ſhall have gained nothing, for it is the ſaliant that muſt be defended, and 2 flanks near 15 fathoms each, 1 of which is only 60 fathoms diſtant, is better than 1 which is leſs than 27, and more than double that diſtance, which is that of the common redans.

Plate XXXV. Fig. 10. If theſe conſiderations do not appear ſolid enough, trace that figure in this manner. Draw a parallel 22 fathoms from 1 of the ſides; at 120 fathoms from the angle, raiſe a redan of 22 fathoms perpendicular, and 15 fathoms demi-gorge; draw 1 line of defence from the angle of the figure to the rentrant of the redan, and the other from the point of the redan to the gorge of the demi-baſtion, which make 25 fathoms; elevate the flank perpendicular to this laſt line.

This angle being ſquare, may be made a baſtion; but ſo crowded, and of ſo little defence, that we ſhould reject ſuch a conſtruction here, as much as in the fortification of places, where it is never uſed, when it can be avoided.

Plate XXXV. Fig. 11. The angle of 120 degrees, being that of an exagon, may be fortified according to all the methods I have given, except in thoſe with tenailles, and broken tenailles; it wants but 30 min. of being enough for this; ſo that it may be uſed, diminiſhing the perpendicular 2 or 3 feet only, for greater exactneſs.

Plate XXXV. Fig. 12. Finally, the angle of 150 deg. is open enough to execute any of the different ſchemes that may be choſen for the reſt of the lines.

Whatever then be the ſaliant, we can flank it according to 1 or more of the methods I have given for regu-

lar

lar fortification, and it is certainly an advantage to confine theſe irregularities to fixed rules, obſerving only, that if the angle is leſs than 60 deg. or that we cannot uſe the crotchets, we muſt make it leſs ſaliant to give it the greater opening.

IV. The unequal heights of the ground, is one of the principal cauſes of the irregularities, as well in the profils, as in the plan of the works.

The ſaliants of every kind of fortification muſt be at leaſt as high as their branches, even ſuppoſing the ground perfectly level; if the part moſt advanced ſhould be loweſt, its parapet would cover it leſs in proportion as 1 would be farther from it; whereas if the ſaliant be higheſt, one cannot be ſeen even from a much higher ground than that we are on.

It is therefore always uſeful, and oft abſolutely neceſſary to raiſe the flanked angles higher than the reſt: the earth taken from the rounding of the ditch ſerves for this purpoſe; as this is of little conſequence, except in even ground, we muſt endeavour to place theſe angles on the higheſt places; we alſo thus prevent the bad effects of the ricochet, and command better in front.

When we cannot by this means prevent being ſeen from an eminence too near, and have not time to raiſe the parapet of the angle as high as neceſſary, there are 2 methods left, little uſed in *France*. The one is to raiſe the parapet of the angle ſome feet, in form of a cavalier, for the breadth of the terreplein, that the troops which occupy the branches may be covered. This the *Germans* call bonnets, and we ſurtouts; there were ſome in the hornworks at *Philipſbourg*.

If it is only ſome particular work we ſhould cover, the ſame method is uſed by turning one or more angles to the enemy: theſe ſurtouts are alſo ſo proper to guard againſt the ricochet, that I am ſurpriſed they are not more uſed in our fortified places.

The

The other expedient ſignifies little againſt cannon, but is eaſily done, and entirely covers the men; it is to place, on the parapet that ſhould be raiſed, a row of gabions larger at top than at bottom, that they may form a kind of loop-holes; *Caligni*, director of fortifications, from whom I had this idea, aſſured me he had uſed it ſucceſsfully. Theſe gabions reſemble much thoſe hampers or baſkets on the rampart, which, according to *de Ville* and others, were formerly uſed inſtead of ſand-bags, if their chief uſe was not to prevent being plunged; a more eſſential one than that for which baskets was invented. If theſe methods fail, we muſt, according to *Vauban*, poſſeſs the commanding ground, either by extending the lines to it, or by good redouts, or ſome other works.

When the line of the front cuts one of theſe eminences, and that we muſt conſequently mount, and deſcend it, was it even parallel to the enemy, we are obliged to break it in ſuch manner, that the ſaliant be at top, and the rentrant at bottom. The reaſon of this, little different from what we have already alledged, is, that if the line was continued ſtrait on, we ſhould in reality be covered in front, but not being ſo on the ſide where the ground falls, the parapet of that part would not hinder our being ſeen obliquely.

We ſeldom project beyond the line, in deſcending a hill, yet it may happen, as in the communication of ſome detached work; the only method to avoid being plunged, is to trace the communications in zig-zags, like the branches of a trench; the more acute the angles are, the leſs ſubject to be enfiladed, and the ſhorter the branches are, the more they are covered by the crotchets.

V. I will add ſome reflections on ſo important a ſubject. We ſhould, if poſſible, poſſeſs the heights, was it only to prevent the enemy from moleſting us from them; yet they are not abſolutely ſo advantageous in themſelves, as commonly imagined.

Theſe,

Theſe, in proportion to their height, diſcover at a diſtance, and command the depth of the battalions and columns of the aſſailants. All have beſides the advantage of being ſecured from the ricochet, and even of diminiſhing the effect of cannon, which, firing from a low place to a higher, with much difficulty enters the parapet, which it batters obliquely in reſpect to its thickneſs.

We ſhould alſo add, that the firſt rank of the enemy being higher than the 2d in aſcending, it is conſequently the only one that can fire on the intrenchment. Theſe advantages are real, but the inconveniencies attending them are more ſo.

It is eſſential here to diſtinguiſh 2 different ſorts of fire; the raſant or grazing, is that which, going in a direction parallel to the horizon, beats down all within its range, and the fichant or plunging, that which fires from a higher on a lower place, and only damages whatever it meets with near the point where it falls.

This diſtinction being underſtood, explains one part of what I would ſay. Whatever is the height, every ſhot that falls, and does not riſe again, will be fichant or plunging, and conſequently leſs dangerous, even ſuppoſing the ſoldier to take aim; and as it is almoſt impoſſible, let the elevation be ever ſo little, to raiſe himſelf enough, it is evident that cannon will have little effect, and ſmall arms ſtill leſs, and this inconvenience increaſes in proportion as the enemy approaches.

This concerns the plan, viz. what is beyond the foot of the hill; as to ramps or ſlopes, I ſhall here ſuppoſe them of 2 different ſorts.

When they are ſo ſteep that the enemy cannot eaſily aſcend, and we can leap from the intrenchment, we ſhall certainly repulſe an enemy out of breadth, and probably in diſorder, with much eaſe; eſpecially if, by imprudence, or too much heat, they are led on too faſt; here alſo we cannot fire on the ſlope without being

ing greatly expoſed, or even without mounting on the parapet.

If the ſlope is gentle or eaſy, we are leſs expoſed, but the enemy will march with as good order, and almoſt with as much eaſe, as on a level, ſo that we do not gain much by it; for I am not of *Folard*'s opinion, that infantry charging from a higher on a lower place, come with greater weight, and the cavalry the contrary.

We may conclude, that the moſt advantageous heights, in all reſpects are thoſe which are ſteep and difficult of acceſs, provided they are ſo ſituated, that flanks may be made to batter what we cannot ſee in front; or elſe thoſe eminences with a gentle and eaſy ſlope, when this natural glacis is near the length of a musket range.

We cannot be too attentive in placing theſe works, ſo that they poſſeſs the ſummit of the hill; at leaſt we muſt take care, that by the irregularity of the ground ſome part of the camp, or the troops when drawn up, be not ſeen from without.

VI. When a village is found within reach of the ſhot, it muſt either be left in rear, or fortified ſo as to ſerve as a flank to the reſt.

This is very important, for if you abandon it to the enemy, it ſerves them as a ſupport, hides their diſpoſitions and motions, and enables them to diſcover yours.

When the village is ſo near as to be hurtful, and in a low ground, or too much embarraſſed with hedges, *&c.* to run the line there, there is not much more to be done than making it a detached poſt: while this poſt ſubſiſts, it will be a ſecurity to that part that cannot be attacked, but by expoſing their flank to the fire of the village: but as it is liable to be attacked, becauſe it is detached, it will be prudent, let the diſtance be ever ſo little, to ſecure a communication, ſo as to prevent its being eaſily ſurrounded.

Some redouts are ſufficient for this; every difficulty would then be overcome, if there did not oft remain incon-

inconveniencies much more conſiderable: we have ſeen in chap. 4. that there are many villages that cannot be fortified; beſides, ſuch a place requires much work, and to guard it requires more troops than we are ſometimes able to detach from an army.

In theſe circumſtances, the common expedient, and which appears the beſt, is to BURN the village; but I affirm from what I have frequently ſeen, and lately at the ſieges in *Flanders*, that unleſs the houſes are all of wood, as in *Bohemia* and the *upper Palatinate*, we gain little by it. What advantage do we reap by ſetting fire to a houſe built with earth or maſonry? the roof, floors and doors conſume, but the walls remain, and they are ſufficient to cover the enemy. We ſhall find that it is not the houſes, ſo much as trees, hedges, and the walls of encloſures, which affords this cover, and the fire does not deſtroy them.

We muſt not have recourſe to theſe means, but when we have time to cut down and level with the ground all that may be hurtful; as it is ſeldom that we do this, but when it cannot be avoided, viz. at the laſt extremity; as we ſeldom reap any advantage by theſe CRUEL actions.

The ſureſt way is to avoid ſuch troubleſome neighbourhoods as much as poſſible. As to leſs conſiderable encloſed places, ſuch as houſes or caſtles, we ſhould not heſitate to poſſeſs them, though of little uſe, for fear they may be hurtful, as they are ſupported with little work and few troops. We have ſhewn how to defend them in chap. 3.

VII. Theſe laſt works are ſo eſſential, that when not found ready made, we are obliged to conſtruct others in their ſtead. One of the moſt eſſential maxims in all fortifications is, not to leave the enemy any cover within a certain extent, which extent ſhould never be leſs than muſket range. If the line or intrenchment is at a diſtance from a valley, too low to be ſeen, or any other

other circumſtances produces the like effect, there muſt of courſe be ſome work added.

The ſame ſhould be done to ſecure communications to heights, when we apprehend they may be hurtful; if we have a dam, a bridge, a ford, or any other defile before us, it muſt be defended near and by a grazing fire. Beſides theſe detached works, others are ſometimes made, which are only ſeparated from the line by the ditch: theſe are made to ſtrengthen a place greatly expoſed, to poſſeſs a point of land, or flank the adjacent parts.

I ſhall not give the various methods of tracing theſe works, as their figure depends on circumſtances; and as I have given ſo many different ſchemes already, no one can be at a loſs in this reſpect; I ſhall only add, that the moſt material thing is to ſecure the communications, and to turn the branches, ſo that they do not fire on the lines; the adjacent parts alſo muſt be ſo turned as not to fire on the branches.

VIII. Woods as well as heights have their advantages and defects; if full of thickets, and difficult to paſs through, and not above 100 or 150 fathoms diſtant, they are advantageous to the defence of the intrenchment, as the enemy cannot make their way through, without being heard by the patroles and advanced guards, which gives us an opportunity of drawing our troops to the places attacked; beſides, they run the riſk of being charged before they can get clear, and are drawn up: in this caſe the barriers ſhould be large, and at a little diſtance from each other, ſo as to ſally out with a conſiderable front, and at many places at once.

If the wood be clear, high, and without brambles and briars, as moſt fir woods are, and are cut through by broad and good roads, as that of *Philipſbourg*, the enemy will be able to conceal their diſpoſitions and marches to attac us when we leaſt expect them, and retreat when they pleaſe, without fear of being perſued,

ſued, at leaſt very ſpeedily, provided they have taken the precaution to line the borders with infantry, to favour their retreat.

If the wood is nearer, the enemy have greater advantages, and if at a greater diſtance, as 400 or 500 fathoms, they cannot indeed fall on the line, ſo very unexpectedly, but their retreat will not be leſs ſecure. When we are maſters to chuſe the nature and ſituation of the ground, it is the general, rather than the engineer, ſhould weigh well theſe conſiderations.

When the line muſt paſs through a wood, and by nature it is incapable of ſupplying the place of one, for reaſons given in chap. 2, cut it down, from the foot of the intrenchment to the rear of the camp, and pile up the fellings at 150 fathoms in front at leaſt.

IX. A moraſs, a hollow, a hollow way, a quick-hedge, even the ſmalleſt brooks, become objects of regard, either to gain advantages from them, or prevent their being hurtful.

A moraſs of any kind is always an advantage, if it extends to the foot of the line, ſince it renders it inacceſſible to cavalry at leaſt: if it be of any breadth, and its bottom boggy, it ſerves as an intrenchment; if neceſſary to line it with a parapet, it need only be an epaulement againſt cannon, conſequently need not be flanked; but we cannot reconnoitre and ſound theſe moraſſes too well, that we may know how far we may depend on them; there are thouſands of examples, and I have ſeen droves of oxen croſſing thoſe with little trouble, which were thought in the army, to be impracticable, and which perhaps were ſo ſome months before.

Hollows, hollow roads, and every thing that may ſerve as a cover, muſt either be enfiladed or flanked by the line itſelf, or as in chap. 7, by ſome detached work, ſo as to diſcover the bottom. Theſe cavities not only ceaſe to be hurtful, but alſo become uſeful, as they are ſo many additional obſtacles to the enemy: if

we find a quick-hedge, and the intrenchment can be ſo turned, as to preſerve it on its berm, it will ſerve inſtead of palliſades.

If there is a brook too ſmall for an inundation, it muſt be dammed up here and there to fill it full to its banks, and form little pools: or, if it runs into the intrenchment, we muſt try to fill the ditch with it; I ſhall not here treat of conſiderable brooks or rivers, having already largely treated of them chap. 9.

X. The different projections of the line, being always determined by ſome one of theſe circumſtances, it is evident we cannot always make the fronts of an equal length, as we are oft obliged to add or diminiſh a certain extent.

The numbers and variety of ſchemes I have given, will be of great aſſiſtance in this reſpect, as they are for fronts of 60, 100, 120, and 150 fathoms, beſides theſe fronts may be diminiſhed if judiciouſly done.

If we would have lines with redans, 30 and even 50 fathoms ſhorter, we may perſue the common methods, without any alteration, except the break of the curtain, as in chap. 6. The fronts of lines with tenailles may, without inconvenience, be reduced to 50 fathoms, by ſhortening the perpendicular, ſo that it does not exceed the half of the front.

The indented branches, fixed at 60 fathoms, may be reduced to leſs than 30, but the flank muſt in this caſe be at leaſt 12 fathoms, and perpendicular; its branch muſt alſo be protected by an adjacent fire, ſuch as that of a higher crotchet. The fronts of other lines cloſed may be ſhortened a 4th, obſerving to follow the proportions of the given dimenſions; the figures being ſimilar, the directions of the fires will ever be the ſame.

If, to the combination of theſe different meaſures, we add what has been ſaid on each particular front, nothing farther need be added; but it muſt be obſerved, that it is better to ſhorten than to lengthen them in this

this caſe, becauſe the fronts generally become ſtronger by the firſt, and conſequently weaker by the laſt.

Observations on the twelfth Chapter.

I ſhall add a few remarks, to what is ſaid in the fifth article on retrenchments upon a hill or riſing ground. The author does not ſeem to think, that a ſudden riſe is ſo advantageous as it is commonly ſuppoſed, as the ſoldiers cannot fire upon the aſſailants without diſcovering themſelves too much: in ſuch caſes, the parapet of the intrenchment need not be ſo high on level ground, and made with a ſteep ſlope or glacis; beſides, wherever there is a favourable ſpot of ground, flanks are made: but ſuppoſe the enemy attacks, he muſt receive a grazing fire along the ſlope without being able to return it; and if the foremoſt ſhould come ſo far as the line, will not a greater body of troops oppoſe him, with all the advantage poſſible, while his front rank only is able to fire. It does not appear to me, that ſuch an attac is at all practicable provided the defenders ſtand their ground. Attempts of that kind have been made, but never anſwered; on the contrary, after ſeveral extraordinary efforts have been made, the aſſailants have been obliged to retire, after having loſt the greateſt part of their beſt troops.

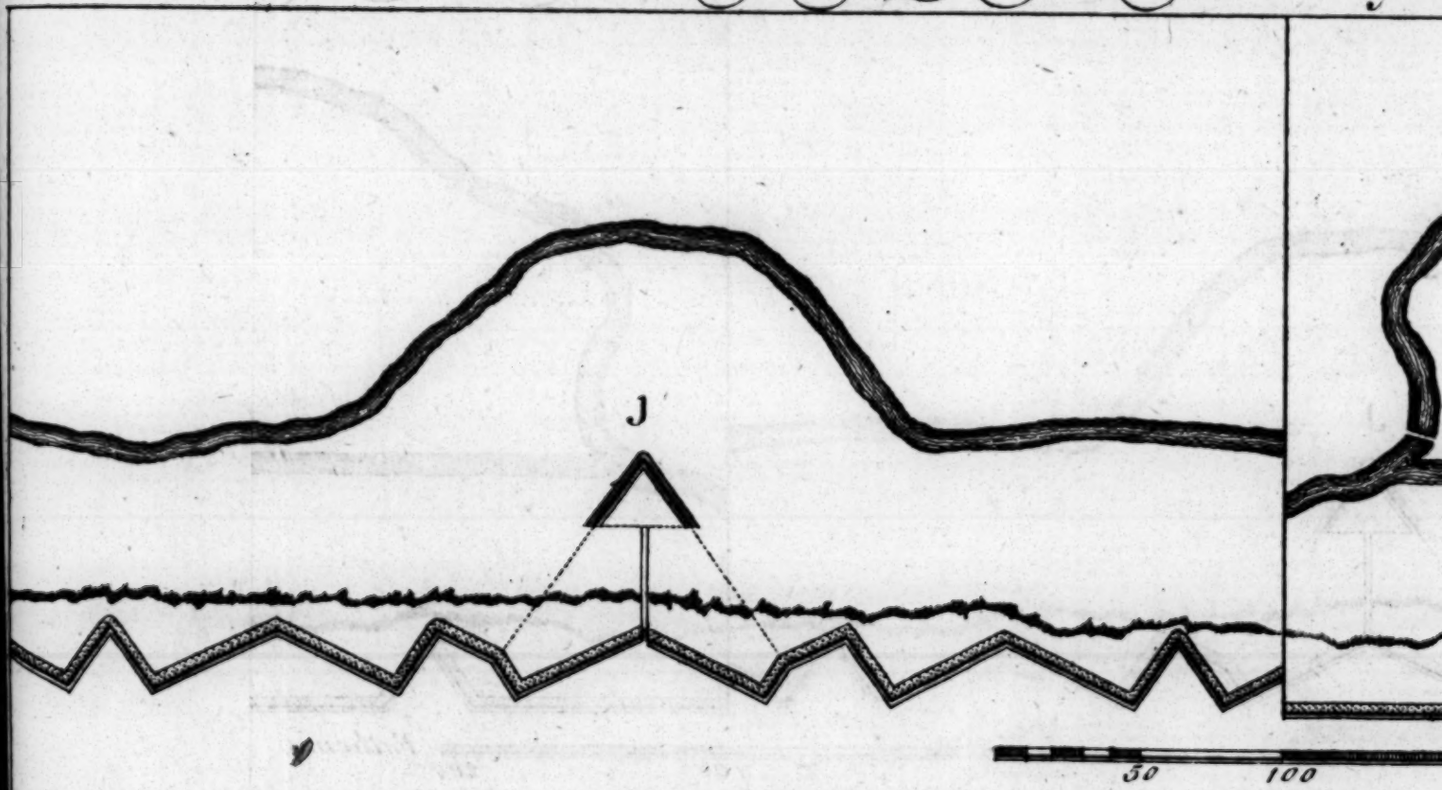
CHAPTER THE THIRTEENTH.

I. *Profils.* II. *Reflection and example.* III. *Defects of profils too much elevated.* IV. *Obſervations on the author's breaks.* V. *Height of parapet.* VI. *Their thickneſs.* VII. *Their pent or ſlope.* VIII. *Their interior height.* IX. *Banquets and their ſlopes.* X. *Ditches and advanced ditches.* XI. *Other ſlopes, and their berm.* XII. *Glacis and covert way.*

I. IT is not ſufficient to give a work the moſt convenient figure in regard to the nature and quality of the ground, to defend its acceſs; we muſt alſo know what ſhould be its height, and every dimenſion requiſite for each particular part, this is what we comprehend under the name profil. This is eſſential, not only in the execution, that each part may produce all its intended effect, but oft in projecting a figure; if we only follow a plan we may be led into an error. For example, the breaks I have propoſed in many places, to diſtribute the fire equally, and give it a better direction, effectually procure that advantage, and in the plan, appear out of the critick's reach, yet we ſhall find in article 4, that they are not without inconveniencies in the elevation. This important part, on which we ſeldom ſufficiently reflect, being relative to the whole, ſhall be the ſubject of this chapter, and the concluſion of this treatiſe.

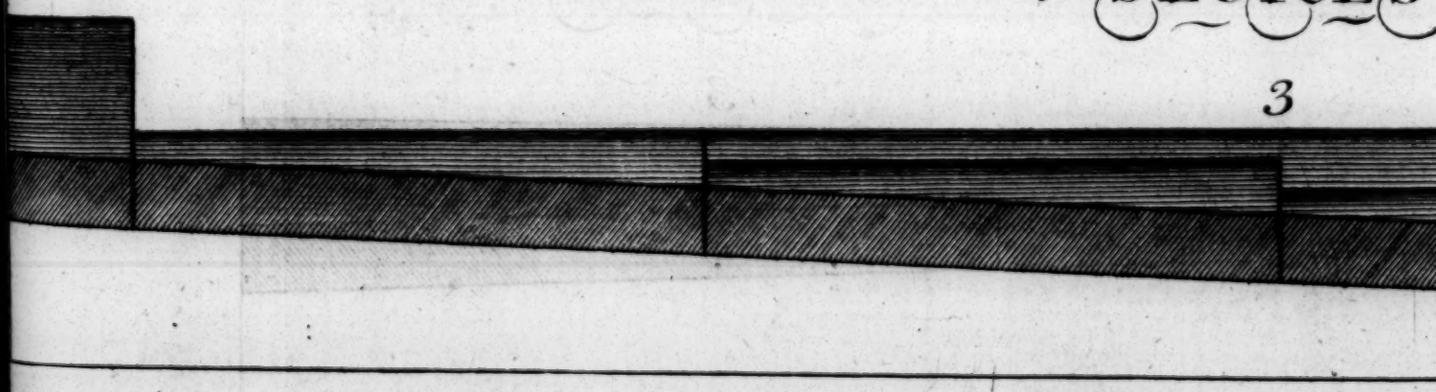
II. I begin by obſerving in general that an intrenchment too weak, tho' well diſpoſed in every other reſpect, ſhould rather ſhew us the neceſſity of a remedy, and the danger, than encourage us with falſe notions. On theſe occaſions the ſoldier always meaſures by his eye the greatneſs of the obſtacles the enemy muſt ſurmount to come at him; and if they do not appear ſufficient, his ſteadineſs diminiſhes, or he is diſcouraged: it is ſeldom that we defend ourſelves as well as we ſhould

LINES COVER'D by



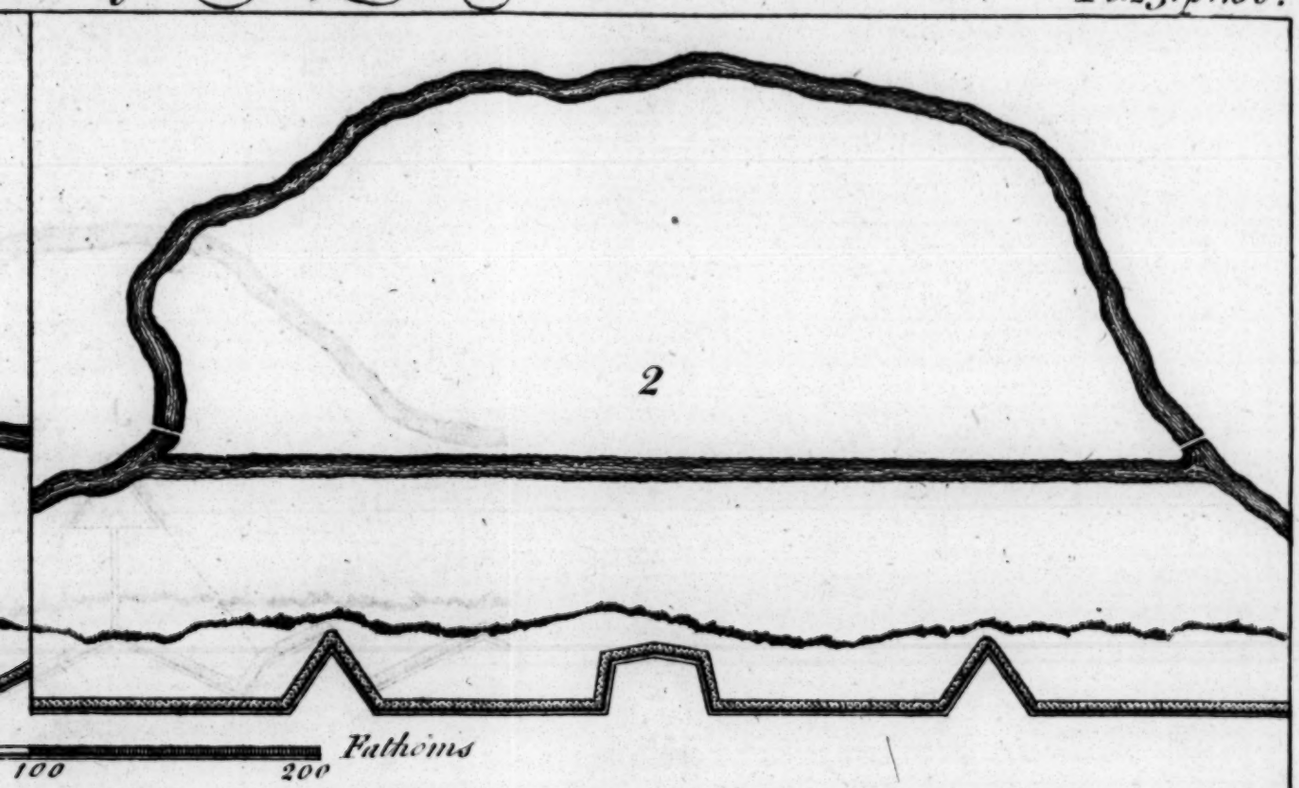
SLUICES

3

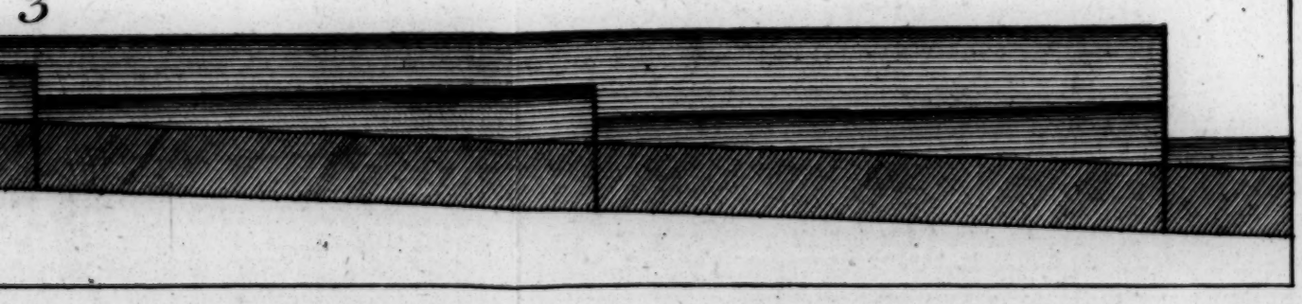


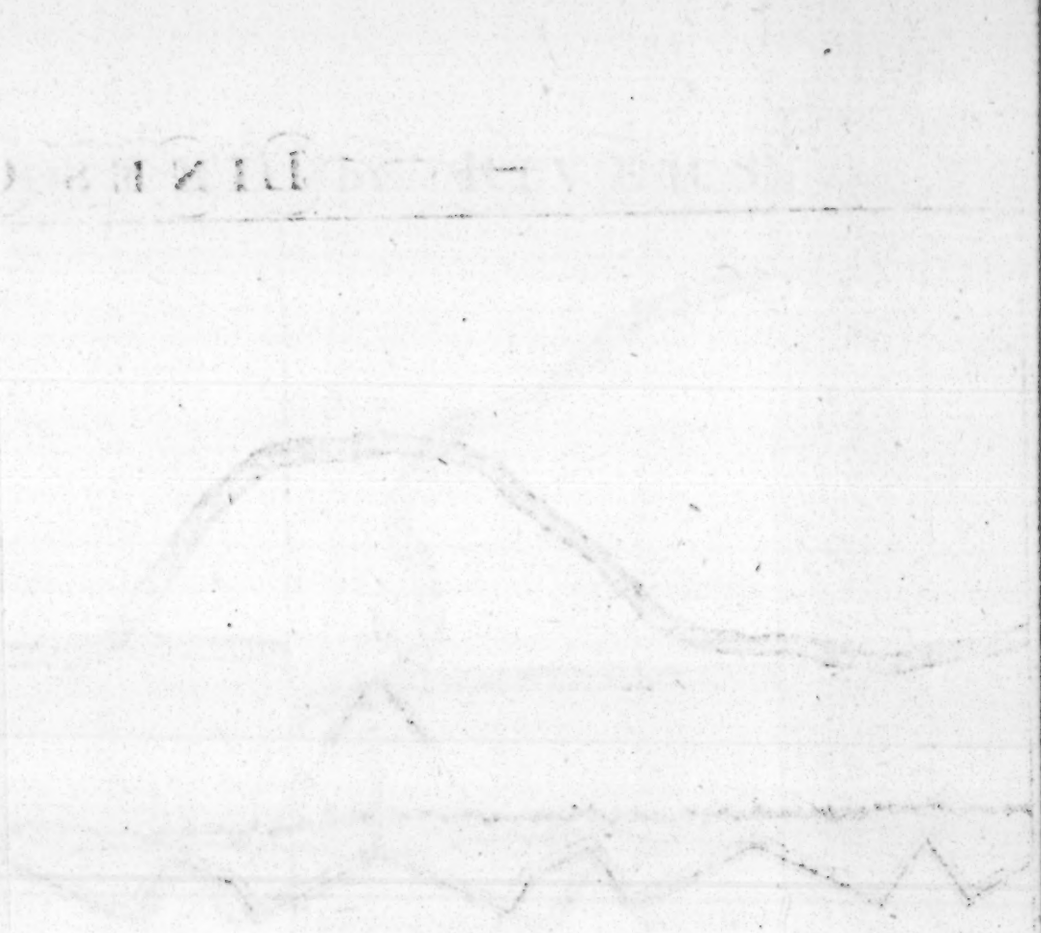
D by RIVERS

Pl. 25. p. 180.



ICES





ſhould, when not ſupported with the hopes of conquering or driving back our adverſary.

An engineer muſt not fear making large profils, when exigencies require, and he has the means to execute. *Vauban* complaining of the negligence of the *French*, in his memoirs of ſieges, would have us make 2 or 3 banquets to the lines of circumvallation, and oftener 3 than 2, ſo that the parapet be raiſed enough to be fraiſed, and to cover the cavalry; either in regard to the ſhortneſs of ſieges, or rather for the reaſon we ſhall explain, he reduced them to one banquet only in his treatiſe of the attac of places; we muſt obſerve that it was by no means to ſave work, ſince in profils which he propoſes againſt ſuccours, viz. in caſes where we fear being attacked and forced, he makes the ditches from 26 to 30 feet broad, and 8 or 9 deep.

What that great engineer obſerves on this head, is too deciſive to paſs unnoticed. He ſays, that *Maurice* and *Frederick Henry*, princes of *Orange*, applied ſo ſtrongly to their lines, that they employed whole months in their conſtruction, that they made them ſo ſtrong, that tho' they were oft attacked, they were never forced; that they alſo added particular forts at certain diſtances from each other, and according to the practice of thoſe times they fortified their quarters ſeparately, and advanced works on the moſt expoſed places to ſtop the enemy, and thus give time to the troops to arrive from the neighbouring quarters to the aſſiſtance of the menaced part: precautions which have ever baffled the enemy's deſigns, and oft endangered their being beat in their retreat. The examples of ſuch experienced generals, related by ſuch an author, will certainly be of more weight than what can be farther alledged.

III. Having thus ſhewn the importance of giving a good profil to field-fortification, we will inquire what dimenſions are moſt proper for them. An height of 9 or 10 feet, as *Vauban* demands, requiring 3 banquets,

that the parapet may cover the cavalry, has without doubt its advantages, ſince ſuch lines may be fraiſed, and ſerve inſtead of epaulements, and are more difficult for the enemy to mount: yet this general has ſince fixed the height of the crown of the parapet, of his greateſt profils, at 7 ½ feet, even where the excavation of the ditch would have allowed an addition, without an augmentation of work: he did not apparently make this alteration without good reaſons, I will therefore endeavour to point them out. We cannot but improve by ſtudying the motives of ſo great a maſter.

We have ſeen the advantages of a grazing fire in chap. 12; and that the more it is fichant, or inclining to a perpendicular, the leſs hurtful it is: but it is always more fichant in proportion to the greater height, at leaſt, as we obſerved, when the ground we defend is not parallel to the lines of fire.

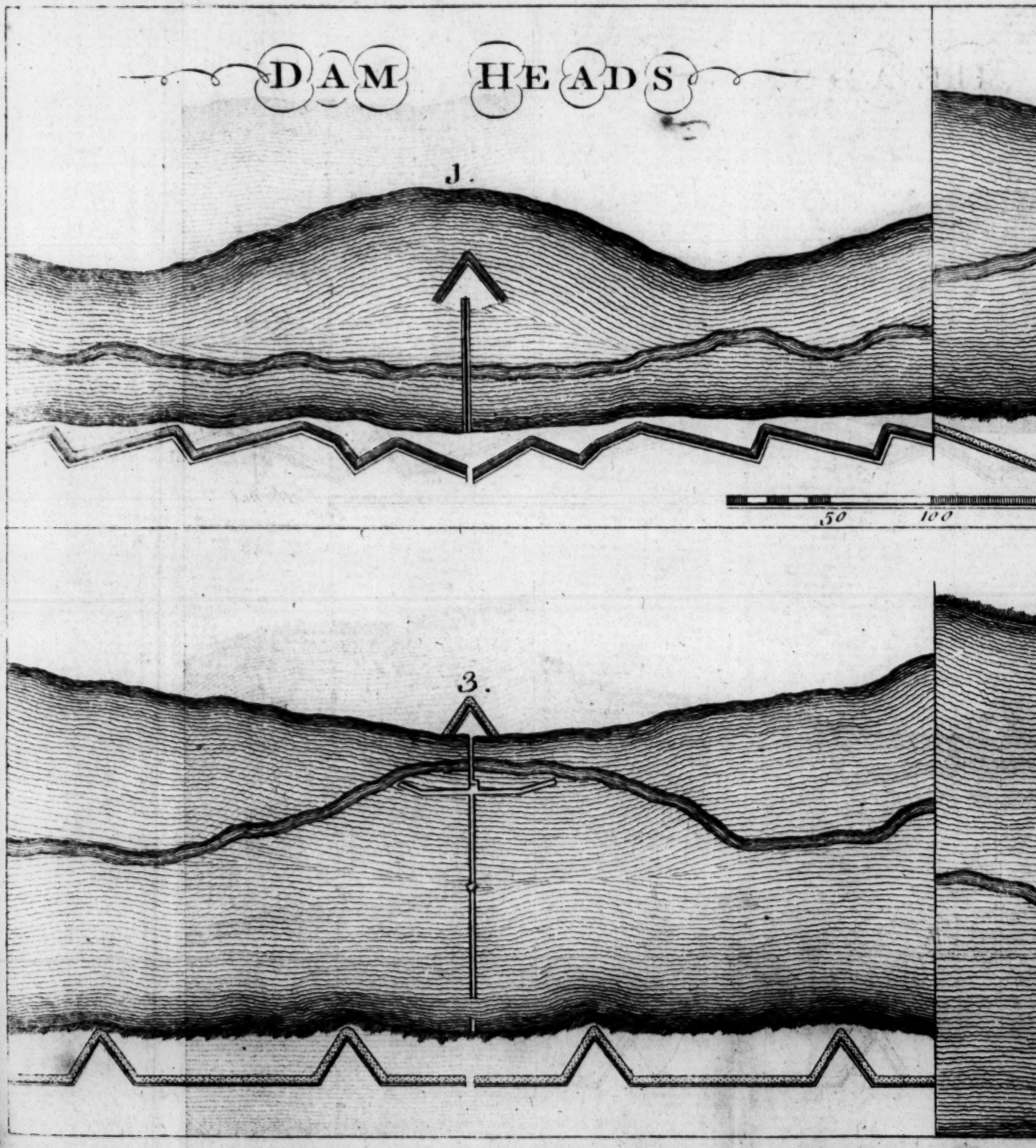
Every elevation beyond * 4 feet 4 inches, which is the height a ſoldier of a middle ſtandard holds his piece to fire right before him, or parallel to the horizon, is therefore always a defect, which muſt be diminiſhed as much as poſſible.

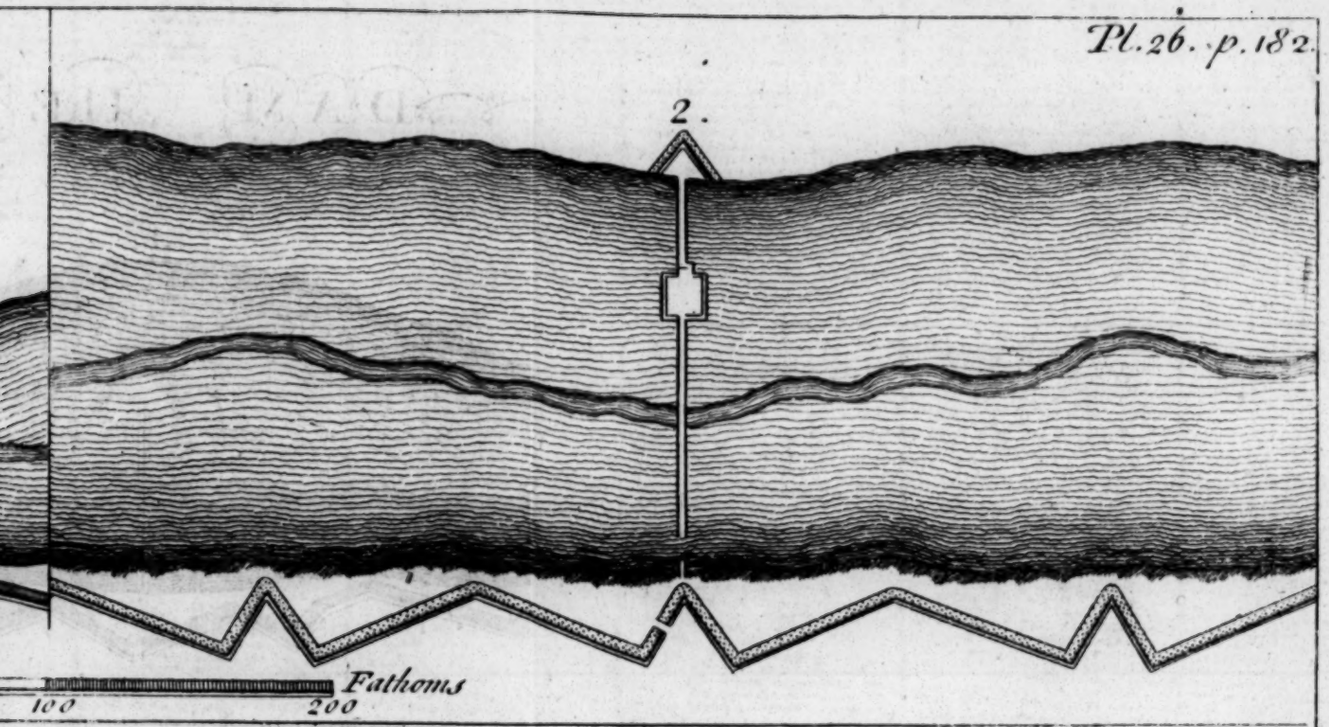
Suppoſing on the contrary it is 9 or 10 feet high, and one foot in a fathom ſlope or plunge, the ſmall arms, by following this direction, cannot reach the ground nearer than 9 or 10 fathoms from the ſpot they fire, from whence ariſes a much greater defect, viz. that the enemy will find himſelf covered from the direct fire, in proportion as he approaches the counterſcarp, near which he will be out of all danger.

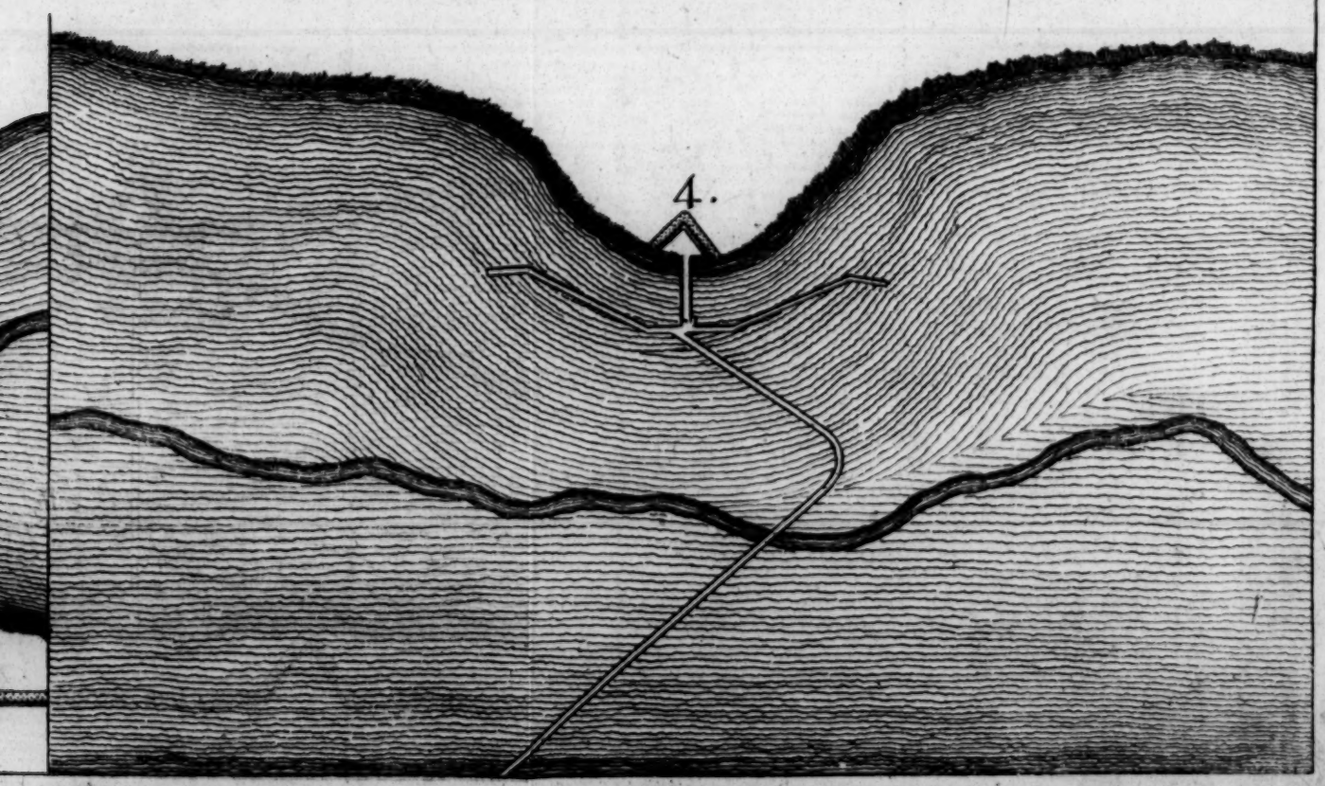
This defect, as we ſhall ſhew, may be remedied, but the firſt always ſubſiſts, and increaſes in proportion to the depth of the ditch, which forms new inconveniencies.

* The reader muſt here obſerve that one foot *Paris* makes one foot and half an inch or 6 lines, *Engliſh* meaſure; this difference, tho' inconſiderable in the plans, is of great conſequence in the profil.

DAM HEADS




2.
Fathoms
100
200


4.

As the bottom of the ditch is not ſeen direct, it is an unavoidable evil, and ſo evident that it is needleſs to quote it, but this muſt be endeavoured to be remedied by the flanks. It is not with field-fortification in this reſpect, as with places; the ditches of the latter, if well conſtructed, are ſeen in all parts; whereas in field-fortification, the ditch is much narrower and parallel to the parapet, and in certain places cannot be ſeen from any part.

Theſe defective parts, in common lines, are along the faces of the redans beginning at the rentrant of the counterſcarp: the ditch cannot be ſeen there but from the extremity of the curtain; and it is evident that the extent, which cannot be diſcovered from thence, not only increaſes by its depth, but alſo by the greater elevation of the parapet. Theſe are certainly the motives that induced *Vauban* to lower his profils; it would have been inexcuſable to have departed from the maxims of ſo great a man.

IV. I here reſume my ſubject, on the propoſed intrenchment. One of the redans, always diſcovering the foot of the next, according to the common method, there are not any of thoſe dead, or defective parts along the curtain, which the breaks neceſſarily cauſe in all mines.

The defect is greater in proportion I own; therefore it is only neceſſary to know, if that is as eſſential as it appears, or whether it is ſo well compenſated by other advantages, as not to reject them, I ſhall obſerve,

1*ſt*, That we are not generally confined to the attac of one redan; if, for example, we include 3 in the attac, the 2 curtains which join them, have no protection to expect, each being then too much engaged in its own proper defence, to aſſiſt in that of another, thus it ſeems to be indifferent.

2*dly*, If the curtain is attacked, as the adjacent redans will infalliibly be ſo too, each will fire directly before itſelf, and in this caſe neither the counterſcarp, nor

the ditch will be defended by any thing; whereas by my method, all reciprocally flanking each other, we cannot particularly defend any one, without alſo defending the part we ſhould.

3dly, That my capitals are covered by many croſſed fires, that are not to be found in common lines: and to avoid repetition, I muſt intreat the reader to recollect what I have obſerved on this chapter, in the different parts of this treatiſe.

I ſhall not alledge that theſe dead angles are even found in ſtars, in demi-baſtioned forts, and in all other works of this kind. However indiſpenſible they were formerly it is not the leſs a real defect *; and we ſhould avoid it, as much as poſſible, viz. without loſing more than we gain by it.

Though this is a fact, we muſt own all inconvenience diſappears when the ditches are full of water; my ſchemes have ſome advantage, in this caſe, and was I miſtaken, I may be permitted to ſay, that treating on a ſubject ſo important, ſimple, yet ſo neglected, their variety will ever be uſeful, and that, by inciting a curioſity or emulation in thoſe that will criticiſe on mine, and may give birth to more happy ideas.

V. I ſhall paſs over thoſe preliminary reflections, to the detail of the profils, our intended ſubject. Every intrenchment of earth, is compoſed of a parapet, 1 or more banquets, 1 or 2 ditches, and ſometimes a berm, and a ſmall glacis. Plate XXXVI.

I have ſhewn *Vauban*'s thoughts on the great height of profils, and the reaſons I had for conforming to his opinion. I will therefore, with him, fix the greateſt elevation at 7 $\frac{1}{2}$ feet from the ground.

Yet this muſt only be in common caſes; there are circumſtances, which oblige us to raiſe it more; ſuch as the neceſſity of commanding the environs, to plunge

* We ſhall find, in the enſuing treatiſe, a method as plain as ingenious, to remedy ſuch defects. Invented by *de Verville*, mentioned in chap. I. article 4.

into

into ſome low part, or to cover a branch, by raiſing the ſaliant.

Works cloſed at the gorge, joined to lines, muſt be excepted from this rule, unleſs when ſo ſituated, as to command the reſt, which ſhould be at leaſt by 2 or 3 feet. If we recollect the nature of the inconveniencies which oblige us to confine the profils to this height, we ſhall find, that they are not always united. I ſhall explain myſelf by examples.

When we elevate a front about 4 feet above the ground we ſhall command, it is evident we batter it with a raſant fire, though the defect of the dead part increaſes: on the contrary, when it is only neceſſary to raiſe a ſaliant to a certain height, to cover a branch, provided the rentrant preſerves the determined height for the breadth of the ditch, the fire becomes more fichant towards the flanked angle, without the ditch being leſs defended.

We may in the firſt caſe reject the breaks, if thought neceſſary; that will be ſo much gained, eſpecially if we can find any means of diſtributing the fire, as well without them; in reſpect to the 2d caſe, that is, of fires too fichant, or plunging, that defect alone is the reaſon which prevents our giving the profil that height we would to works without flanks, or to thoſe that have them too oblique, which conſequently do not defend their ditch.

I do not here ſpeak of the cover the enemy finds againſt a direct fire, by approaching a work too much elevated, becauſe that is eaſily remedied, as already ſaid. A parapet ſhould never have leſs than 6 feet elevation above the ground, without which it only covers in part thoſe that are behind it; thus the difference between the higheſt and the loweſt is reduced to 1 $\frac{1}{2}$ foot.

VI. The thickneſs of the parapet varies much more than the height. In regard to this, the deſign and nature of the work muſt be conſidered. 3 feet is enough for that which is not expoſed to cannon, for example,

the

the intrenchment of a grand guard; 4 ½ feet is ſufficient for works that cannot be battered but at a diſtance; the reſt have 6 or 8, and even 12 feet is allowed for intrenched camps, heads of bridges, redouts, and other pieces intended to ſtand, or that may be expoſed to a briſk fire of artillery, or a long attac.

The thickneſs is not exempt from a defect, but of little conſequence, as it conſiſts in unavoidably ſhortening the branches.

I do not here treat of the reduction of the ſides of polygons, inſcribed in other ſimilar figures, what I mean is more eſſential, at leaſt in the raſant or grazing defence, ſince it diminiſhes the ſaliant, and conſequently the protection of the flank: we muſt conſider that what we gain by the rentrant is no defence in this reſpect, ſince it is viſible, that when the flank is perpendicular, as we ſuppoſe, that which is within the line of defence, fires on that part it ſhould graze.

The laſt is certainly a great defect; we may correct it in baſtioned lines, by advancing the curtain to this interſection, and more eaſily, yet in every caſe, by rounding the interior of the parapet of that part, if ſo ſcrupulous an exactneſs was not an error in practice, where too minute an attention to trifles oft creates negligence in more eſſential parts.

VII. When we conſider that the plunge or ſlope of the parapet generally determines the direction of ſmall arms, it is obvious, in whatever manner it is traced, it is never without inconvenience; for we do not diſcover the counterſcarp at the bottom of the ditch, but in proportion as this ſlope is great, and in proportion to its increaſe, its direction varies from the raſant line.

Theſe objects being incompatible, we muſt find a mean between them that ſhall be moſt proper. This has been ſufficiently treated of, in the treatiſe of the attac of places; we there find parapets of 6 feet thickneſs, which have 1 ½ foot ſlope or plunge: this appears exceſſive to me, not only becauſe the fire becomes too

fichant

ſichant or plunging, but alſo weakens the crown, and by perſuing this direction the ſoldier will diſcover himſelf too much, and, as we ſhall find in the next article, much more than he ſhould.

I would not have above 12 or 15 inches ſlope in a fathom, to which I ſhall add this obſervation. The higheſt profils commonly having the deepeſt ditches, this additional height and depth increaſe, the one the cover in front on the counterſcarp, and both that in the bottom of the ditch.

We muſt therefore give the leaſt plunge to the loweſt and weakeſt parapets, and increaſe the others in proportion to their height, which is not inconvenient, for beſides their greater thickneſs, the top cannot be battered but horizontally, and conſequently with little effect.

On this account I find the ſlope at 1 foot in a fathom for profils 6 feet high, and an increaſe of 1 inch in every $\frac{1}{2}$ foot, giving 13 inches to thoſe of 6 $\frac{1}{2}$ feet, 14 to thoſe of 7 feet, and 15 inches to thoſe of 7 $\frac{1}{2}$ feet.

Thus ſuppoſing the ground level, theſe different fires fall equally on the counterſcarp at 6 fathoms from the point they depart, and at a little diſtance from each other in the bottom of the ditch. For profils of an extraordinary elevation, the greateſt ſlope, that is, 15 inches, appears to me ſufficient.

VIII. 4 $\frac{1}{2}$ feet is generally allowed to the interior part of the parapet. A cuſtom ſo perſued, ſeems an eſtabliſhed maxim. This rule would have been leſs followed had it been more ſtrictly examined; it is proper for the conſtruction of places whoſe parapets ſink in time, and have alſo much leſs plunge or ſlope; but circumſtances varying, it cannot be proper here.

I know by myſelf, that a man of 5 feet 6 inches, ſtanding as he ſhould do the left foot 18 inches diſtant from the upright of the crown of a parapet 4 $\frac{1}{2}$ inches, which is the common ſlope, fires with more eaſe horizontally, than if it had a plunge of 8 inches in a fathom.

thom. As few ſoldiers are of this ſtandard, it is not ſurpriſing that ſo many ſhot are loſt in the air.

There is but 1 remedy for this; it is not only to diminiſh this height, but alſo to diminiſh it in proportion to the plunge, this circumſtance is ſo eſſential, that he ſhould be near 6 feet high, to fire over a parapet 4 feet and a half high, and 18 inches plunge in a fathom, ſuch as mentioned in the preceding article.

Therefore a horizontal parapet, ſuch as thoſe of ſome communications, and other works no higher than 4 feet 6 inches from the ground, ſhould not be more than 4 feet 4 inches; in regard to others, they ſhould be lowered in a proportion of 4 inches in a foot plunge.

It will be objected, that the ſoldier will be much more expoſed; I acknowledge it, but of what ſervice is a ſlope we cannot uſe? Beſides, a ſoldier on theſe occaſions naturally ſtoops, ſo that more than his head is never above his firelock.

Baſkets, or ſmall gabions, ſuch as mentioned in article 4. of the preceding chapter, would be of great uſe here, ſince they remove all difficulties, at leaſt, in reſpect to the fire of ſmall arms.

IX. The exterior height of the parapet being regulated by the interior and plunge, there is nothing to be ſaid on that head.

A man in the attitude of firing does not poſſeſs much more room than 2 feet; 3 feet is then ſufficient for a banquet, yet we generally allow 4 $\frac{1}{2}$, that a ſoldier may ſtand behind, or paſs in the rear of him that fires.

This breadth is allowed from the foot of the palliſades when there are any.

The banquets ſhould be no more than 3 feet high, it is much better to make 2 of 2 feet each than 1 of 4, becauſe a ſlope, when ſteep, is always eaſier to mount when ſo ſhort.

Three feet at moſt is ſufficient for the lower banquets, they not only ſerve as ſteps, but alſo to draw up

up the ſoldiers on, to relieve thoſe that line the parapet.

The ſlopes of banquets may alſo be regulated by their height; when they are only 1 foot, the natural ſlope is enough, as they have only to ſtep a little higher on 1 of 2 feet; I allow to the baſe 1 ½ height, and 2 heights to thoſe that are raiſed 2 or 3 feet.

In narrow places, to manage the ground, we may form ſteps with hurdles 12 inches high, and 9 broad, which ſerve inſtead of a ſlope.

X. The exceſſive breadth of the ditch, if it is not full of water, creates a defect in durable fortification (or that of places) which is, that batteries on the crown of the glacis, or on the terreplein of the covert-way can, without plunging much, ſap the foot of the revetement or face of the wall: but there is no reaſon to apprehend that, in theſe kinds of fortification.

The greater the breadth, the more advantage we reap here; the enemy is more expoſed on the counterſcarp; the length of the dead or undefended parts, afore-mentioned, diminiſh; if the ditch is to be filled up, the work becomes more tedious, and conſequently the enemy are expoſed much longer to a fire very terrible becauſe of its proximity.

We need not fear making the ditch too broad, yet it muſt be regulated by the time and number of workmen allowed us, alſo by the quantity of earth we have occaſion for.

It is not ſo in regard to its depth: as in flanked works it naturally increaſes the dead parts, I would not have it exceed 7 ½ feet. As to works not flanked, where no protection is to be drawn but from the parapet, alſo in ditches full of water, it cannot be too deep, ſince it always is an addition to the difficulty of acceſs, without any inconvenience.

On the contrary, I think the depth ſhould not be leſs, if poſſible, than 6 feet, which muſt be preferred to its

its breadth, otherwiſe the enemy may eaſily leap over, or too eaſily fill it up.

The diſtance of the advanced ditch from the counterſcarp is regulated by the precautions mentioned in chap. 2. Having ſeldom occaſion for the earth taken from it, we make it ſmall, and finiſh the little glacis beforementioned. I would have the ſlopes of this ditch, dry or wet, meet at the bottom; in the firſt caſe the enemy cannot ſtand there, in the other, it will not be leſs difficult to paſs: their depth muſt at leaſt be 6 feet, and their breadth 7, that they may not be eaſily leaped over.

XI. Slopes depend on the conſiſtence of the earth, though we cannot determine any thing poſitive in this reſpect, it is proper to form a general rule to avoid errors.

The nearer the ſoldier is to the crown of the parapet, the better he can follow the direction of the ſlope or plunge; therefore the inſide will be better to be quite perpendicular; but as this can ſeldom be done, we give it as little ſlope as poſſible, which is commonly about one third of the height. *Vauban* gives to thoſe of the ſcarp and counterſcarp one third of the breadth of the ditch; I do not ſee his reaſons for this, it is evident that the nearer theſe parts approach a perpendicular, the more difficult they are to aſcend and deſcend; it is therefore by the nature of the ground, and not the breadth of the ditch, that this muſt be regulated. In ſandy ground the ſcarp muſt conſequently be a foot in a foot ſlope; but with ſtrong and bold earth, $\frac{2}{3}$ or $\frac{1}{2}$ may be ſufficient. We cannot give it leſs, becauſe this part ſupporting the whole parapet, may otherwiſe run the risk of falling down, but as the counterſcarp is not in the ſame ſituation, we may ſcarp it as much as poſſible, eſpecially when the work is to ſubſiſt but a few days. I only treat here of dry ditches; when they are wet, or full of water, theſe ſlopes muſt not be ſo ſteep to allow for the waſte made by the water.

Some-

Sometimes we find light and poor earth, which cannot be uſed without danger. In this caſe we muſt not only increaſe the ſlope, but alſo leave a berm of 2 or 3 feet between the ſlope and the foot of the parapet, which berm muſt be rounded, that the enemy may not halt there, and take breath.

XII. In ſeveral parts of this chapter I have obſerved, that for want of giving all the neceſſary plunge or ſlope to the parapet, the enemy are leſs expoſed to a direct fire, in proportion as they advance to the counterſcarp: ſo eſſential a defect, eſpecially in works without flanks, did not eſcape *Vauban*; he remedies this, by forming with the remainder of the earth a ſmall glacis, which cannot be mounted, without the enemy loſing this advantage.

Simple as the conſtruction of this work is, it requires ſome attention; if the glacis is too high, it ſerves the enemy as a cavalier of the trench, to fire plunging; if too low, it does not produce the deſired effect.

Vauban ſeems to have fixed this height at 4 $\frac{1}{2}$ feet below the crown of the parapet. We ſhould never give it more, eſpecially if we follow his profils, ſince the ſummit of the glacis is thus on a level with the banquet; as to giving it leſs, that muſt be regulated by the direction of the plunge, the only object being to diſcover the enemy entirely, or at leaſt lower than the waiſt, when he is on the edge of the ditch; below the waiſt, that is, about 2 feet from the ground, becauſe they generally ſink themſelves on theſe occaſions.

The ſame muſt be obſerved for the ſlope; that is, it muſt be ſuch, that there be no part where a man is not ſeen entirely. In conſequence of theſe maxims, the glacis is perfect, when without being too high, it is in a line with the plunge, or ſlope of the parapet.

This glacis has beſides this, 2 other advantages, 1 in adding to the depth of the ditch, by raiſing the counterſcarp, the other, in partly covering the work from the fire of artillery.

Some-

Sometimes we make a covert-way to redouts, heads of bridges, and other works depending only on themſelves, if their ſmall elevation does not appear an inſurmountable obſtacle: in this caſe I would ſink the counterſcarp, to preſerve the neceſſary command to the crown of the work. This loſs ſeems more than compenſated by this raſant, or grazing fire, which I draw from the covert-way, and which cannot be obtained from the parapet, before the enemy are on the glacis.

The deſigns here referred to, will explain my ſentiments; it will ſtill be better if the crown of the glacis be level for ſome feet, as the fire following this direction in a flat, and even ground, will be the moſt advantageous in every reſpect.

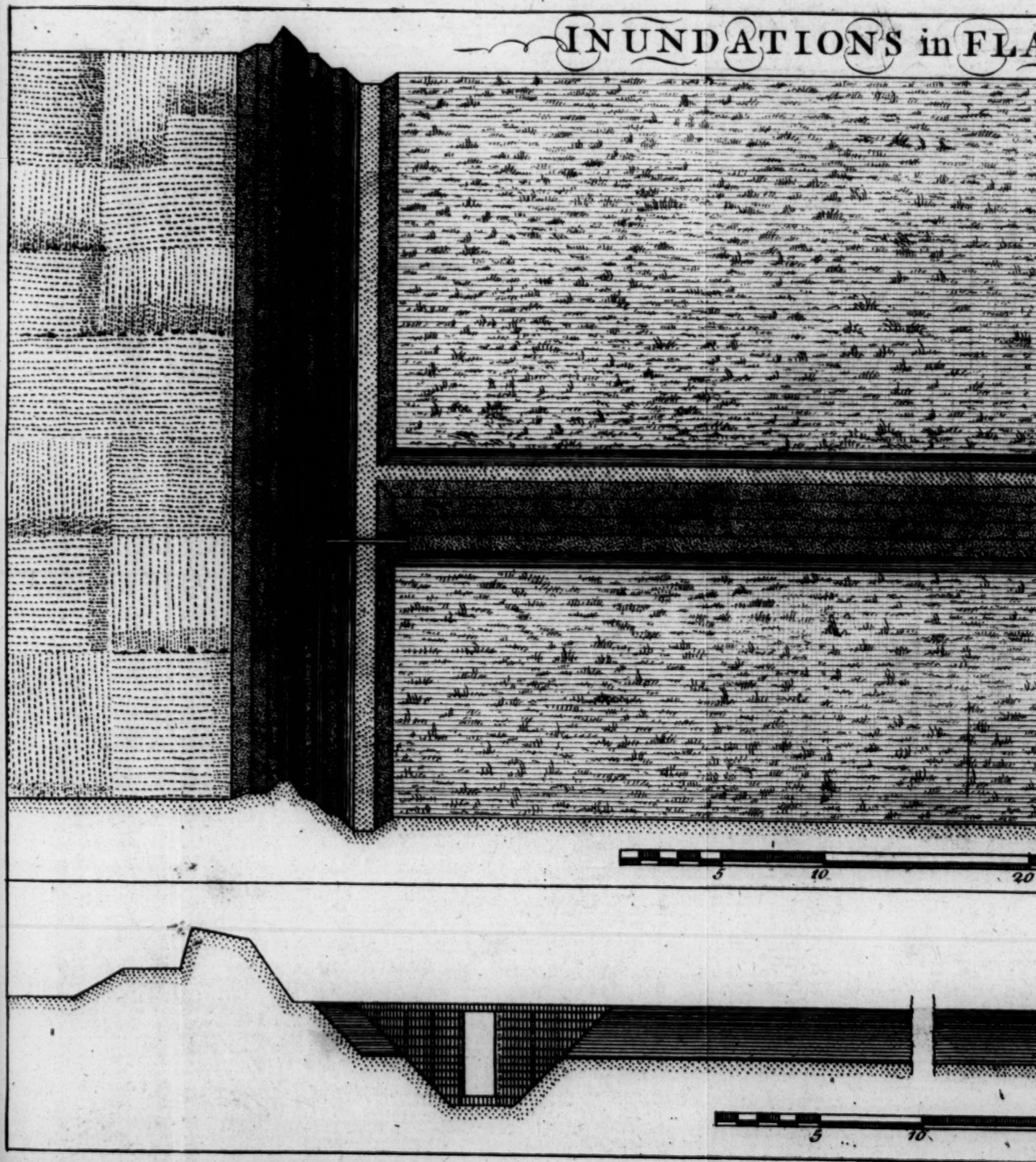
Observations on the thirteenth Chapter.

Tho' the plans of all the different works, are ever ſo well laid down, yet, if the profils are not well regulated, the works loſe a great deal of their advantages; and as the ground is ſeldom on a level from one end of a retrenchment to the other, or before it, as far as cannon-ſhot, a profil that is very proper in one place is not ſo in another, where the ground changes its level. It is therefore the engineer's duty to know what profil is neceſſary, in regard to the ſituation: I could give many examples, where the ſoldiers could be ſeen to their very ſhoes, at a ſmall diſtance from the parapet. The profil ſhould therefore be altered not only on account of the ſituation of the line, but alſo on the ground before it.

When the proper height of a profil is determined, its thickneſs or ſtrength muſt be next conſidered, and where cannon can be brought againſt it, placed nearly on the ſame level, or higher than that of the line, no leſs thickneſs can be given to the parapet than 12 feet, and if time will permit it ſhould be from 15 to 18 feet, for no leſs can ſtop a cannon ball; if the battery is lower than the level of the line, from 6 to 12 feet thick

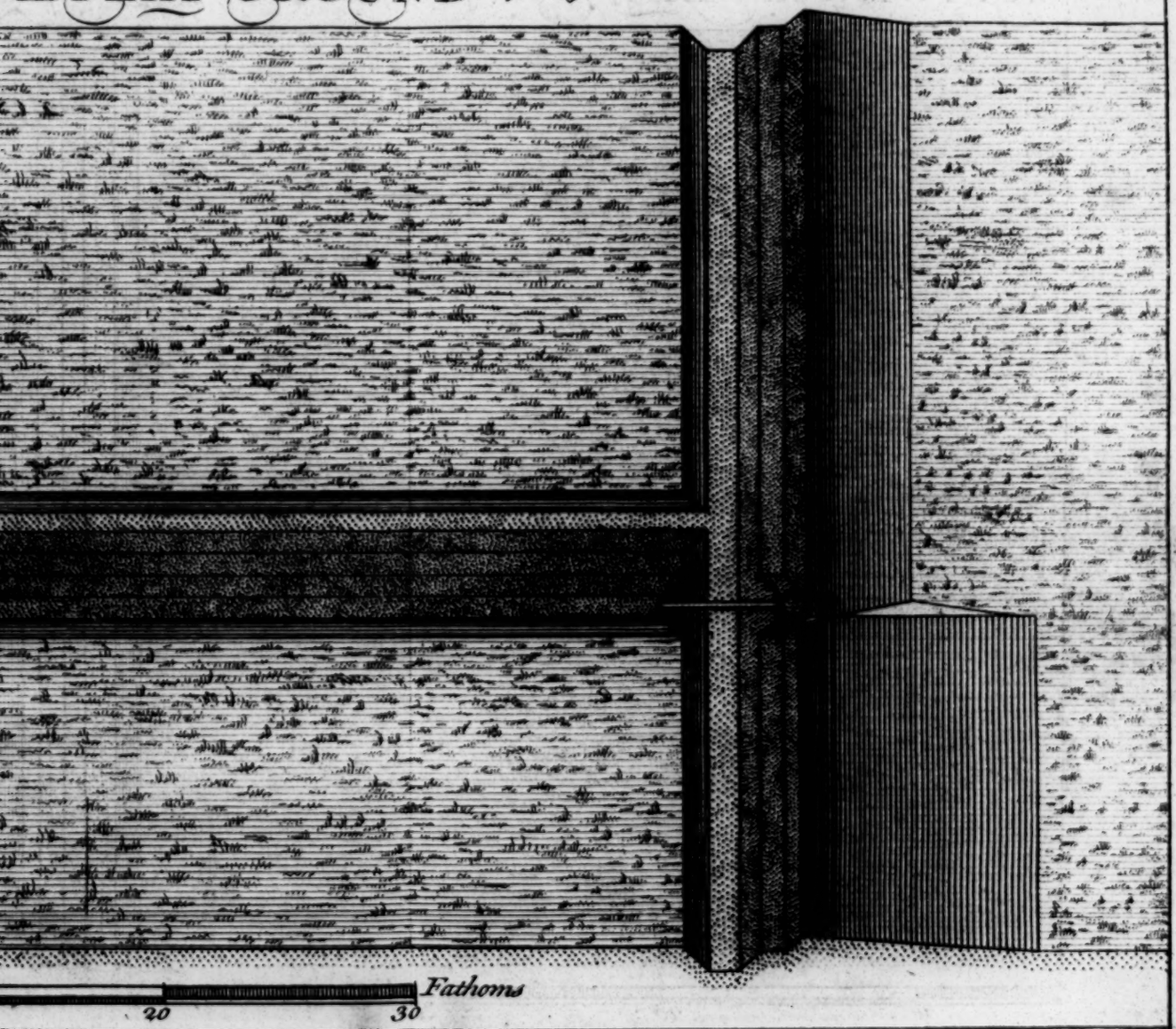
will

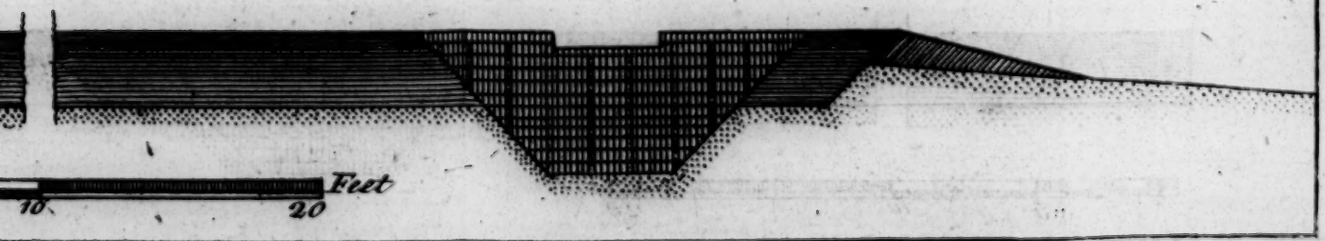
INUNDATIONS in FLA



in FLAT GROUND.

Pl. 27. p. 192.





will do; ſince the ſhot will in this caſe fly upwards after it has hit the parapet. In ſuch places, where the enemy cannot bring any cannon againſt, a thickneſs from 6 to 9 feet will do.

When a parapet is obliged to be made very high, ſeveral banquets or ſteps muſt be made for the ſoldiers to mount and fire; as the fire from a high parapet diſcovers the enemy but at a diſtance, and cannot hurt him when near, there ſhould be flanks made if poſſible to ſcower their ditches; and beſides, the ſlope of the parapet muſt be as great as conſiſtent with ſafety. This defect may alſo be remedied, by flinging part of the earth taken out of the ditches, on its counterſcarp, in the form of a glacis, and leaving a banquet for the ſoldiers to ſtand upon, and to fire from thence, till the enemy comes cloſe, and retire afterwards thro' the barriers. *Vauban* made his ditches uſually larger than was neceſſary to have earth enough for the parapet, whoſe height he fixed at 7 feet 6 inches Fr. meaſure, which makes about 8 feet of ours. In ſuch caſes, the remaining earth may be thrown on the counterſcarp as before, which will make the fire grazing from the parapet, all along this glacis. When time will permit, a 2d ditch with pits full of ſtakes, before the part of the intrenchment moſt eaſy of acceſs, will prove a very great obſtacle to the enemy in his approach.

As to the proper ſlope of the parapet, it intirely depends on the height of the profil, and the nature of the ground before it, it ſhould always be, if poſſible, ſuch as to produce a grazing fire, which cannot be done when the parapet is high, without raiſing a glacis on the outſide, as already mentioned. As the author has been very attentive in explaining the ſeveral parts of profils, and how they are to be made according to the circumſtances that may happen, I ſhall conclude with recommending to the reader always to have the draught before him, when he reads any part referred to them.

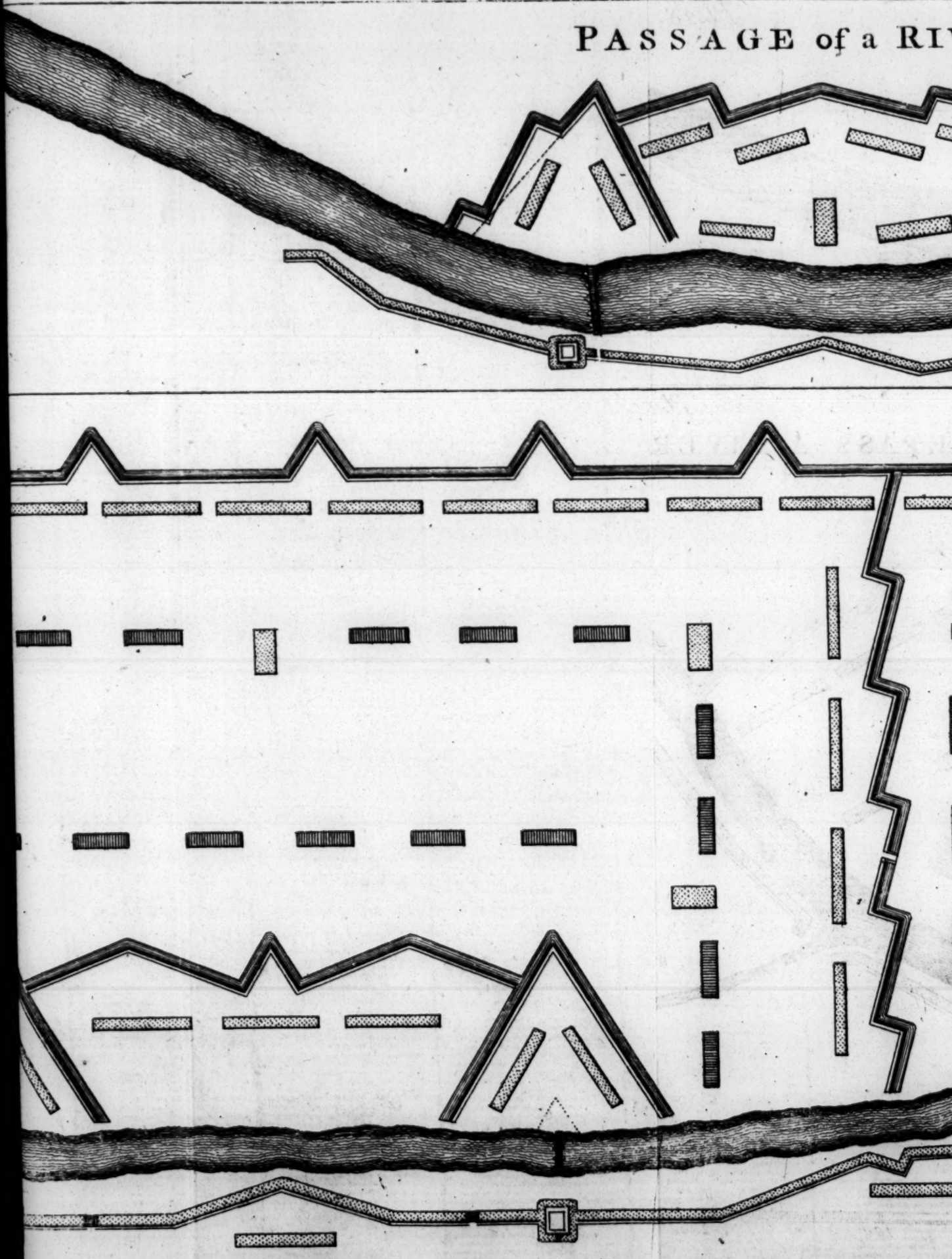
FINIS.

BOOKS publiſhed by J. MILLAN, Bookſeller, oppoſite the Admiralty, Whitehall, 1773.

1 THE Drummer's Inſtructor, with the Engliſh and Scotch Duty, Beatings, Marchings, Calls, &c. by R. Spencer, Drum Major in the Guards.
2 Half Pay Certificates, Atteſtations, Furloughs, Diſcharges, Inliſting Bills, &c.
3 Major Rogers's Journal of the late War in America, 5s.
4 His conciſe Account of America, alſo the interior Parts, their many Nations and Tribes of Indians on the Great Lakes and Rivers, their Cuſtoms, Government, Number, &c.
5 Ponteach, or the Savages of America, a Tragedy, 2s. 6d.
6 Timberlake's Memoirs of the Cherokee Nations, 4s.
The above Four have great Encomiums by all the Literati.
7 Petiver's Natural Hiſtory of about 7000 Figures of Birds, Beaſts, Inſects, Corals, Foſſils, Plants, &c. on above 300 large Folio Copper-plates, and about 800 Figures to Ray's Hiſtory of Plants. N. B. To this Edition is added all his ſcarce Pieces of Natural Hiſtory, and above 100 new Plates, 6 l. 6s. or 7 l. 7s. with the Surinam Inſects coloured; the whole coloured, 21 l.
8 The Hiſtory, Analyſis, &c. of above 200 very rare Flowering Plants, Flowers, Parts of Flowers, Flies, &c. drawn and engraved on 19 Folio Plates, by the late ingenious George Ehret, F. R. S. &c. beautifully coloured from his original Drawings, 2 l. 2s. unbound.
9 Dillenius's General Hiſtory of Land and Water Moſſes, &c. 1000 Figures on 85 Plates, collected, drawn and engraved by him, 1 l. 11s. 6d.
10 Sheldrake's Herbal, on above 116 large Folio Copper-plates, drawn in the moſt maſterly Manner, from the Originals, when in their higheſt Perfection.
11 Sheldrake on Heat and Cold, for Green Houſes, 1s.
12 Columella on Agriculture, by Gibſon, 4to. 14s.
13 Palladio, finely engraved by Ware, 7s. 6d.
14 Hill's Review of the Royal Society, 10s. 6d.
15 Dr. Sharpe's Engliſh Hebrew, and Engliſh Latin Grammars.
16 ——— Defence of Chriſtianity, 3s.—Oligarchy, 1s.
17 C. D. of Dorſet on the Militia.
18 ——— ſhort Hiſtory of a late Reſignation.
19 Cateſby's American Plants fit for Britiſh growth, coloured 2 l. 2s.
20 Tandon's French Grammar, to learn without a Maſter, 2s.
21 Nollet's Hiſtorical Compendium of the Bible, Engliſh and French, 12mo.
22 Prior's Poems, and Negotiations, 2 vol. 12s.
23 Signals and Flags of all Nations, Navy Laws, &c. 5s.
24 Coins, Weights and Meaſures of all Nations, 5s.
25 Captain Bontein's large new Map of Jamaica, 6s.
26 Common Prayer, French and Engliſh, 10s. 6d.

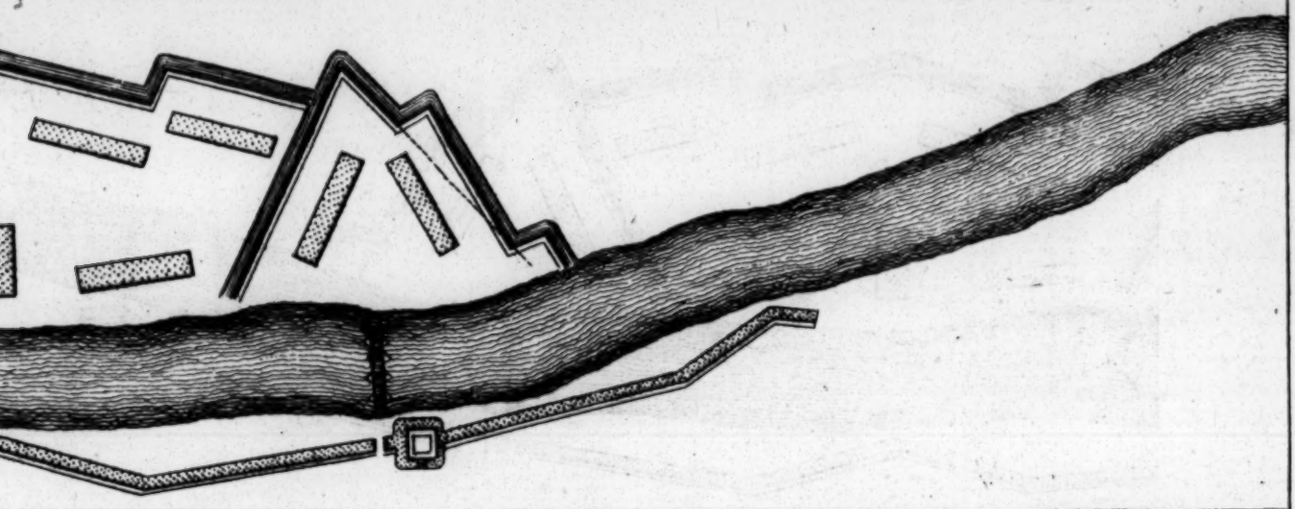
BRITISH MUSEUM

PASSAGE of a RI



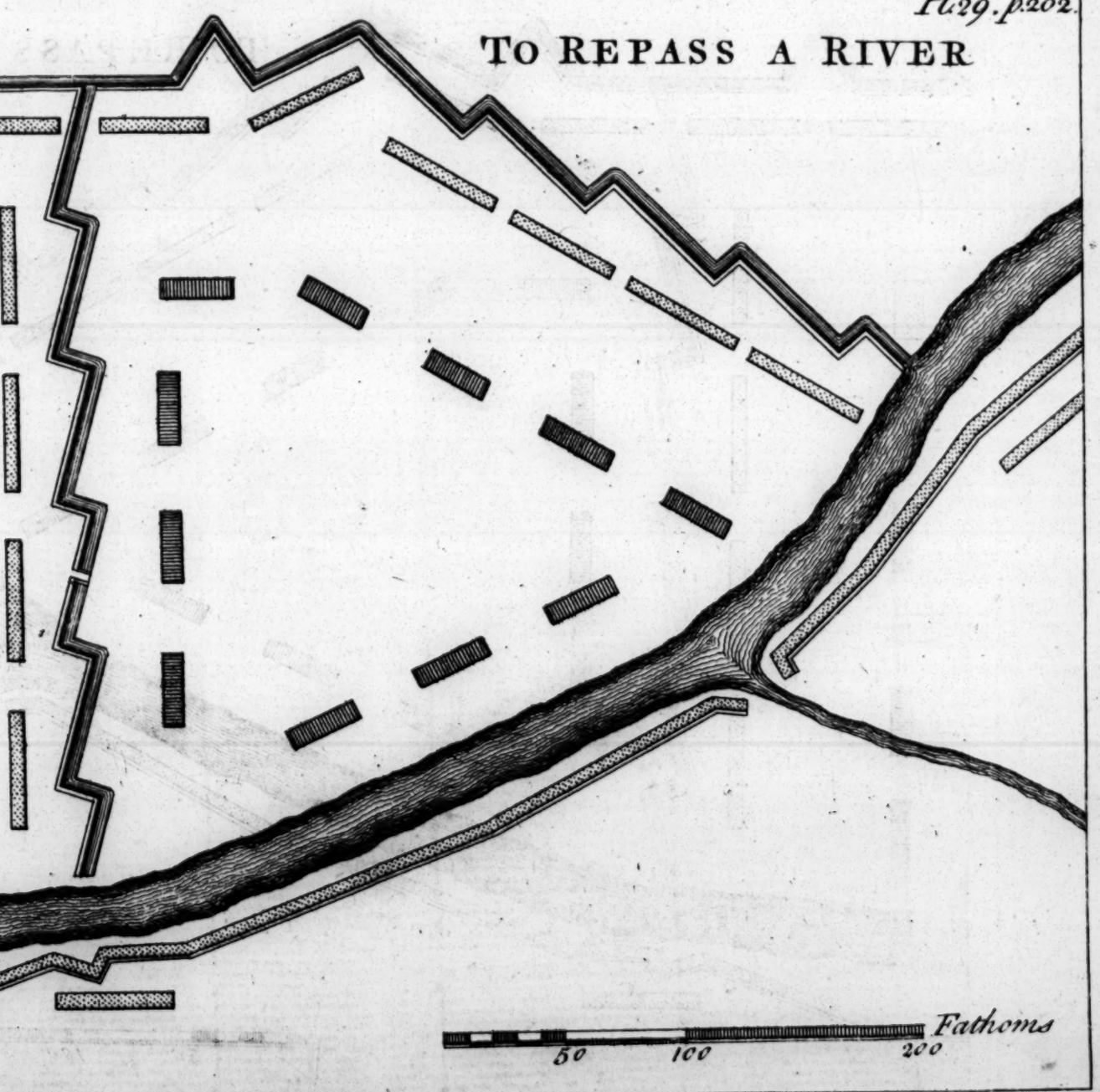
Pl. 28. p. 202.

of a RIVER.



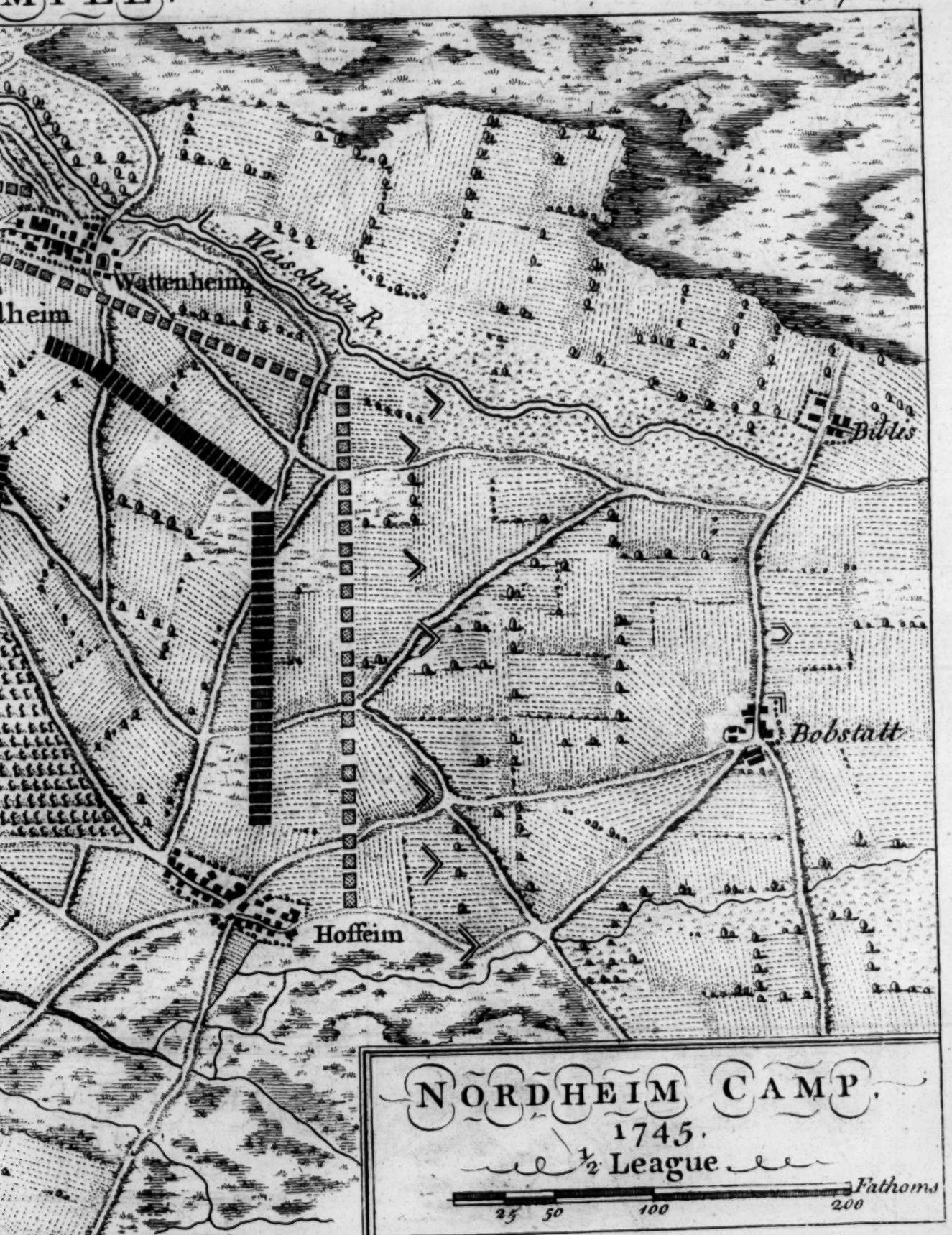
Pl. 29. p. 202.

TO REPASS A RIVER



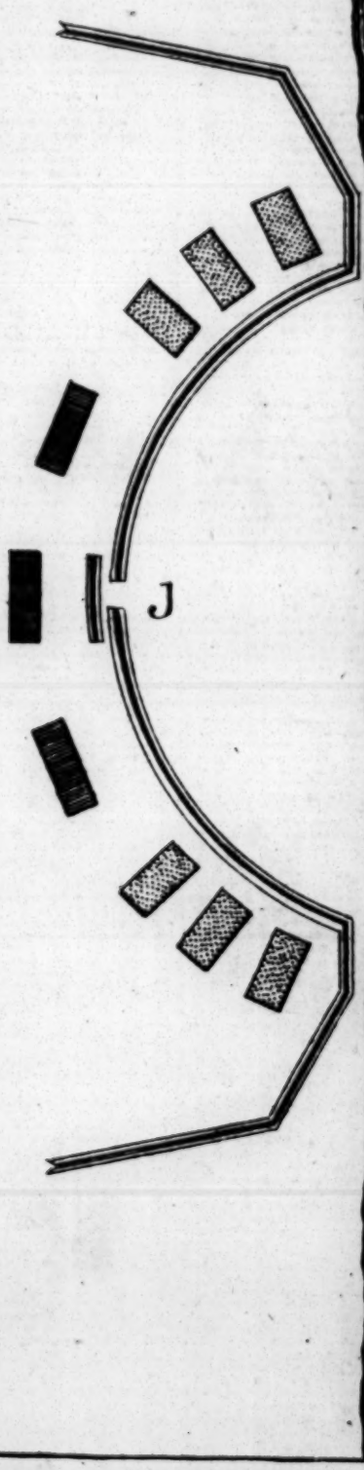

Rindurheim
Nordheim
Hernsheim
Neuhausen
Ruins of a Convent
WORMS

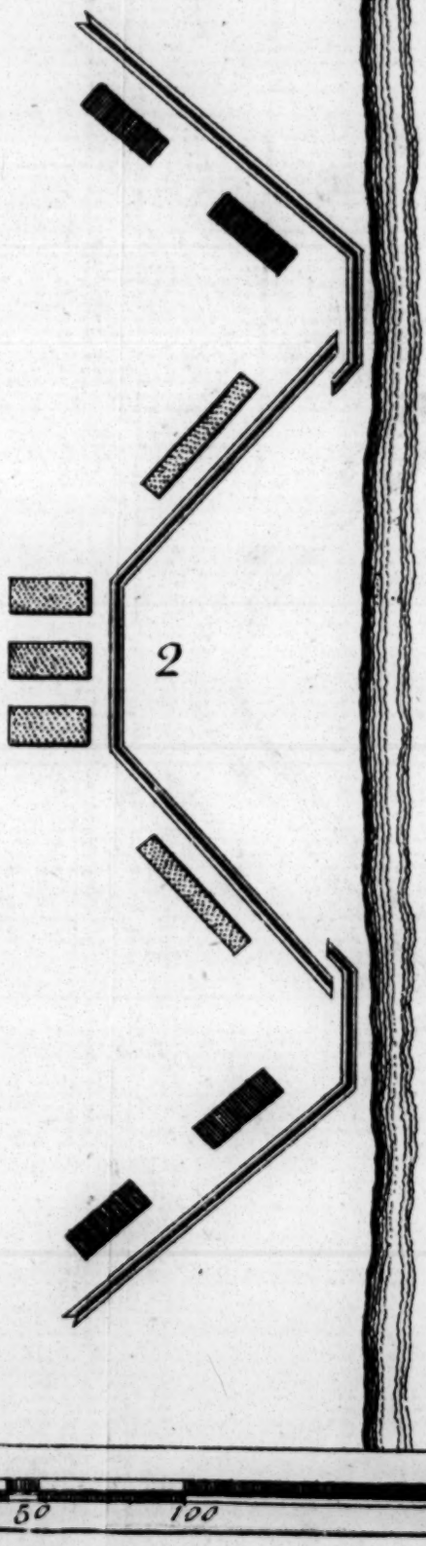
Pl. 30. p. 210.

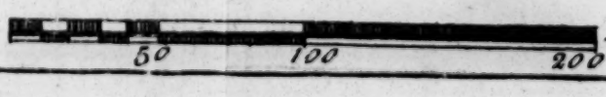


NORDHEIM CAMP.
1745.
½ League
Fathoms
25 50 100 200

To PREVENT the PASSAGE of a

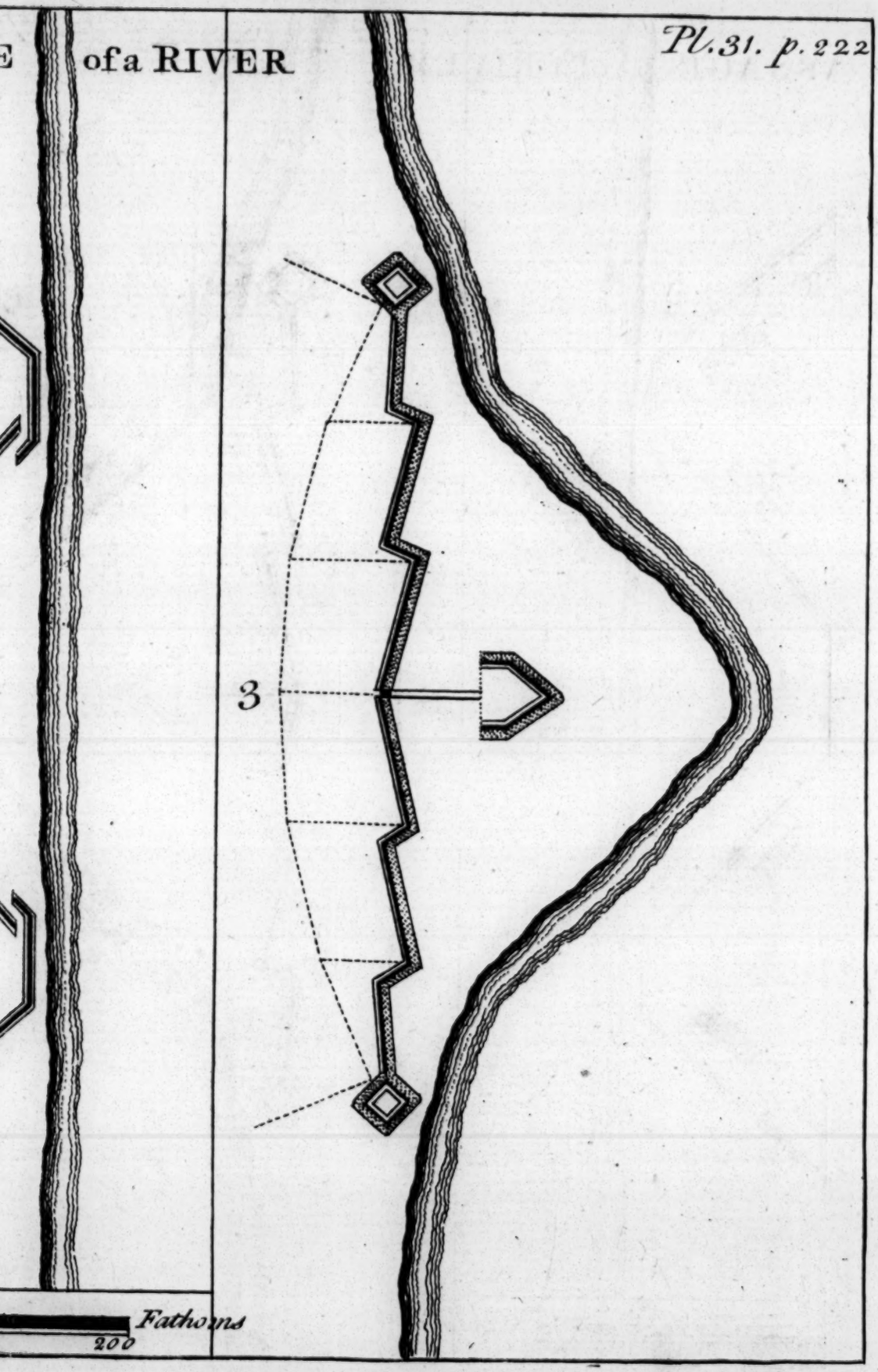




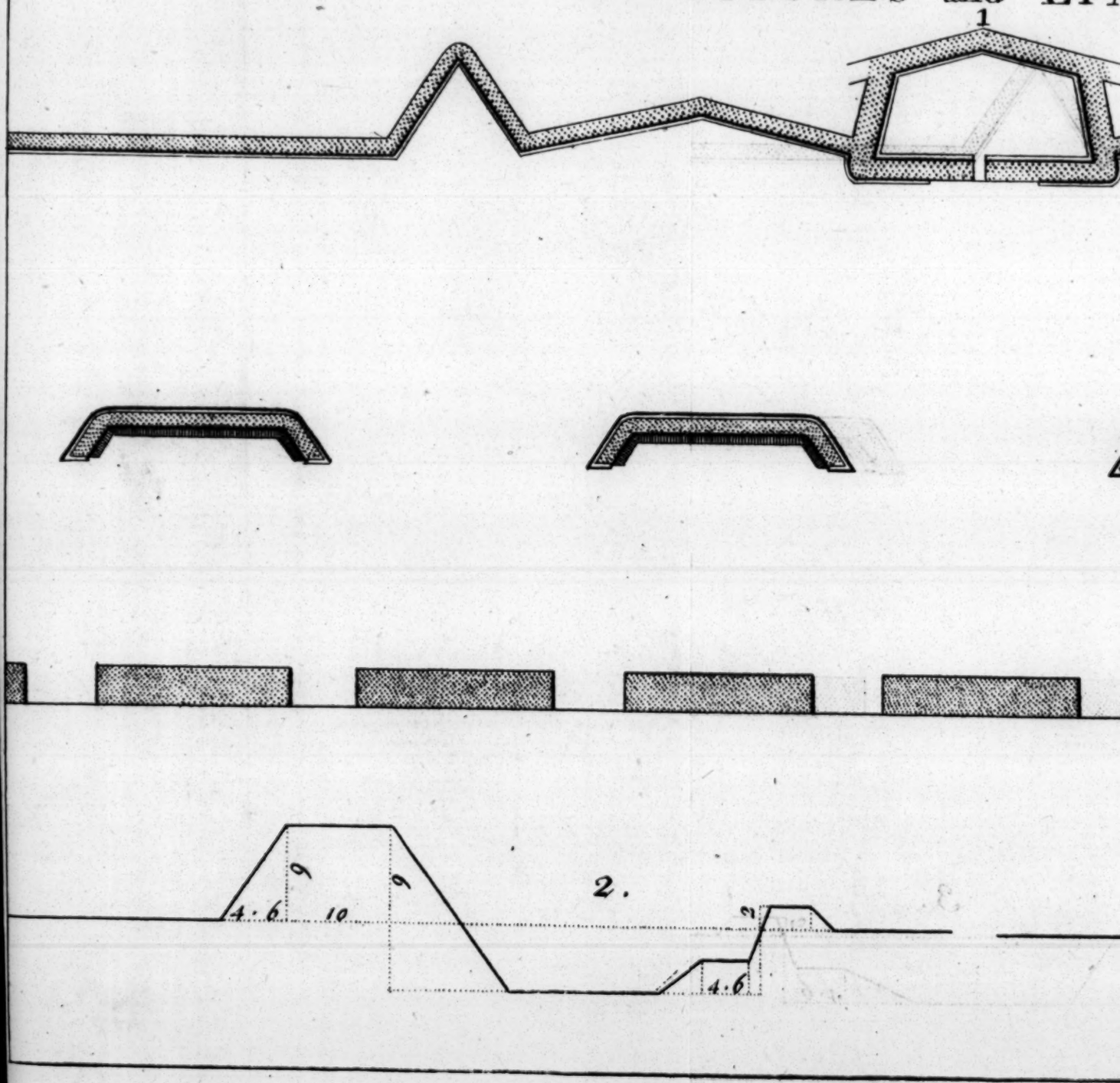


E of a RIVER

Pl. 31. p. 222

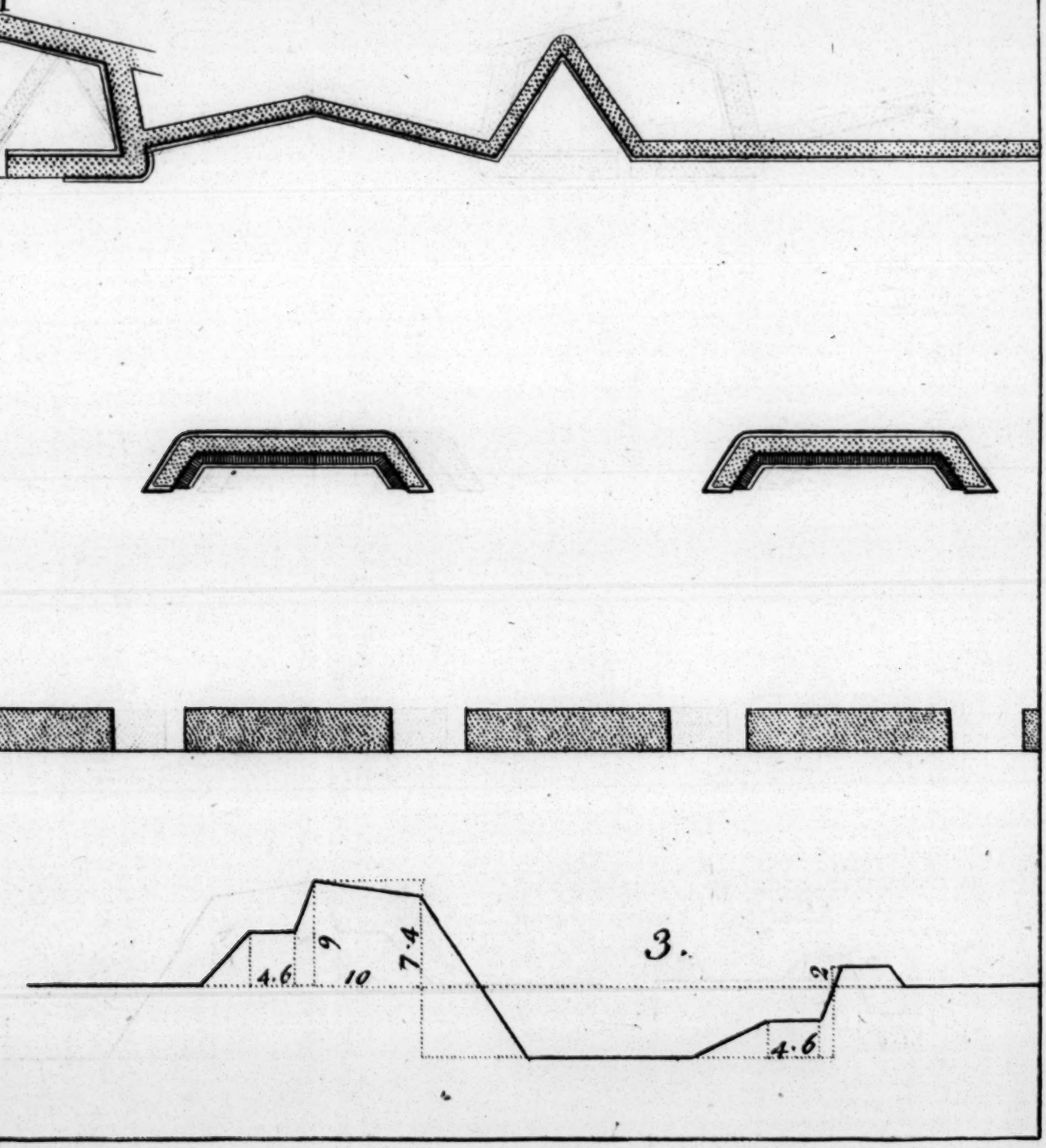


INCLOSURES and EPA

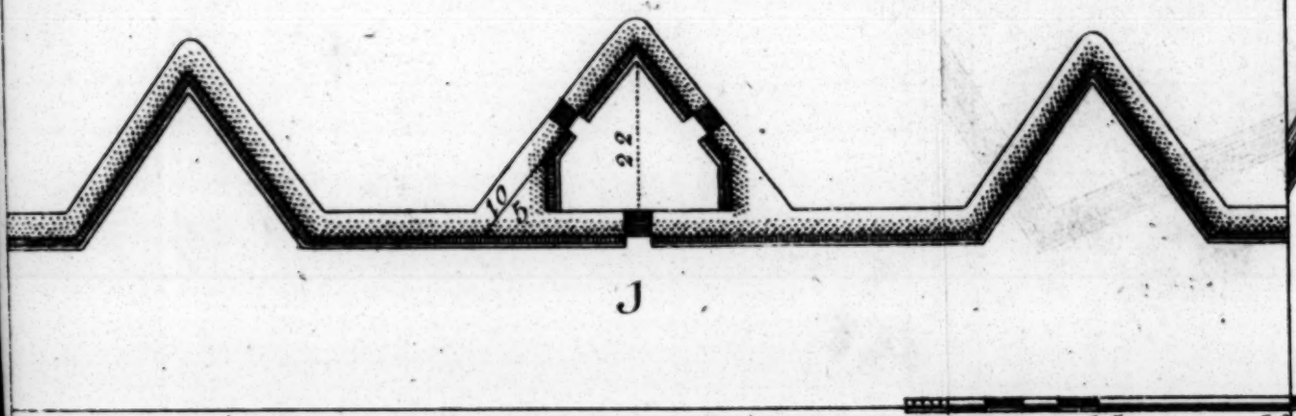


d EPAULEMENTS.

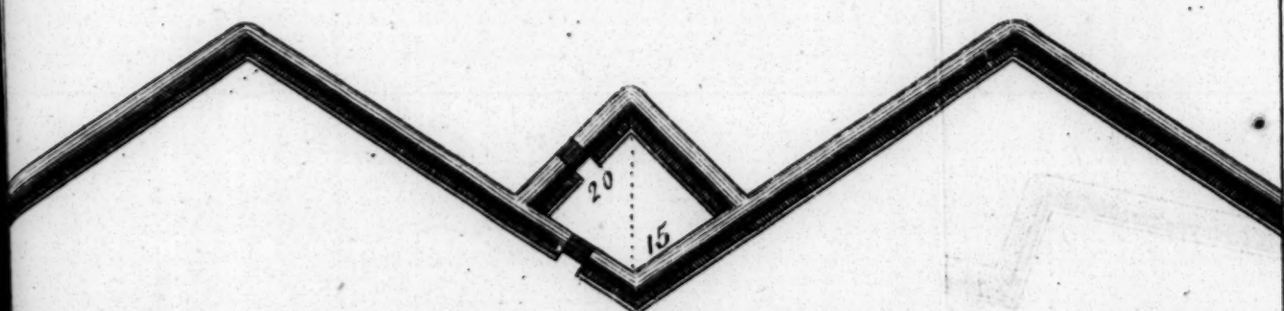
Pl 32. p. 230.



GATES and LIN



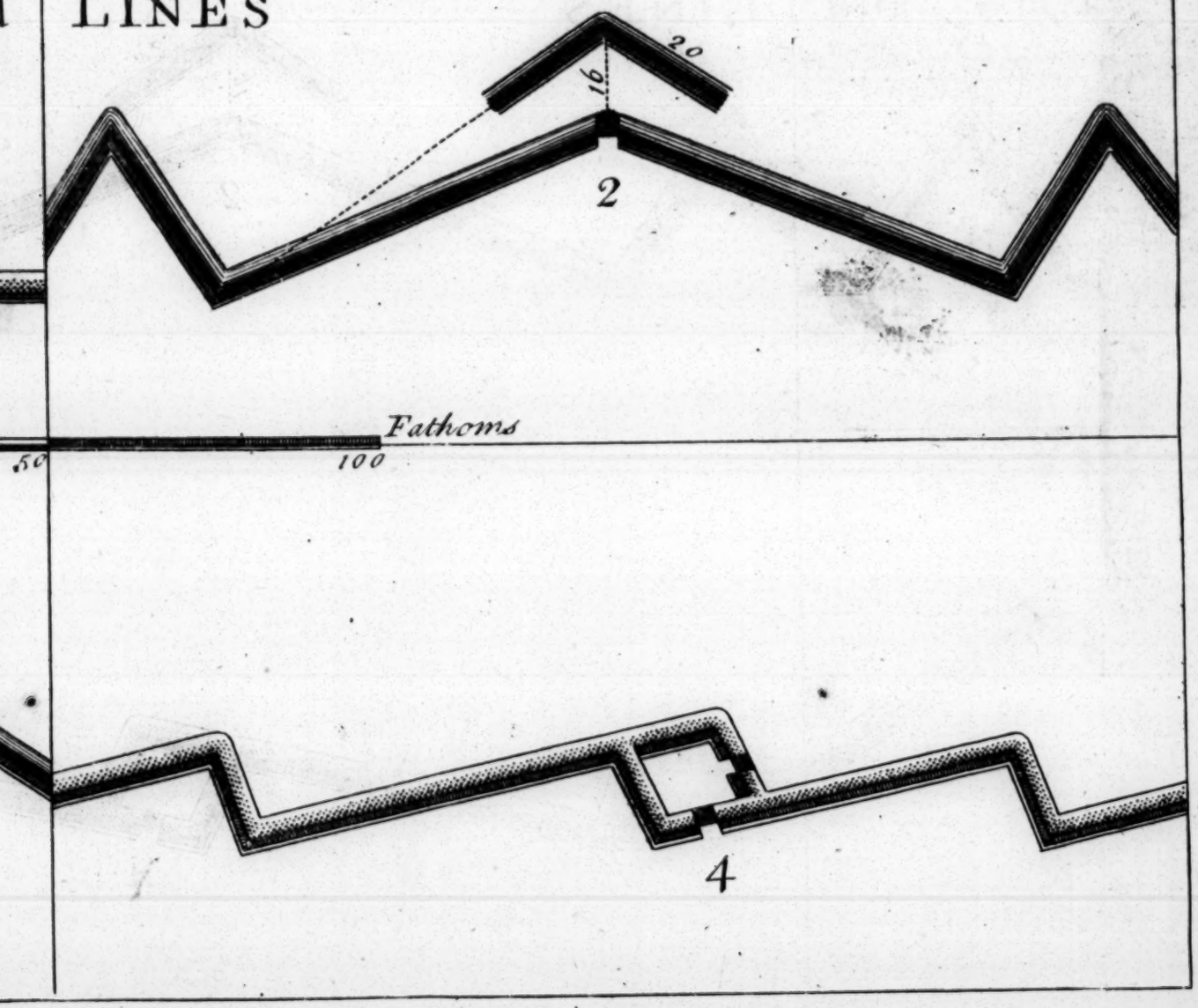
J



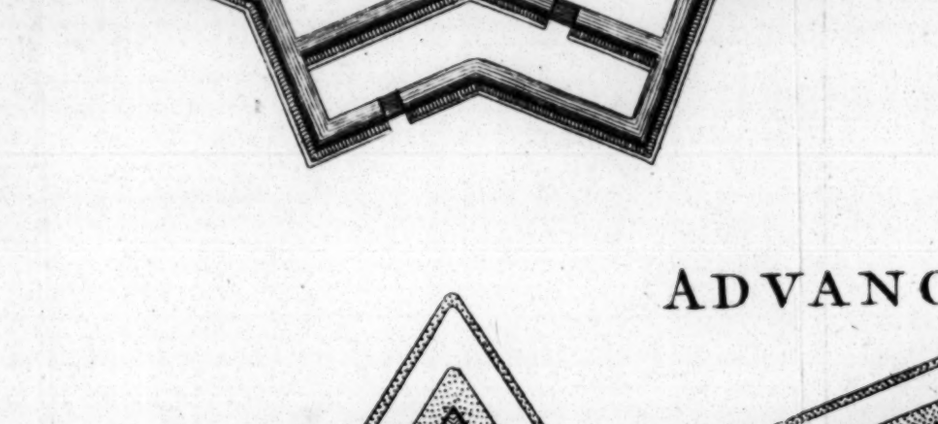
3

Pl. 33. p. 232.

LINES

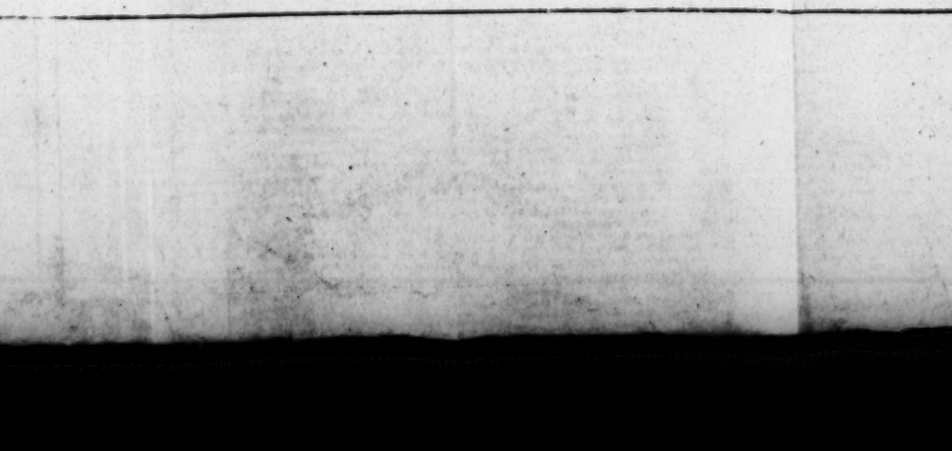


GATES of LINES and BA

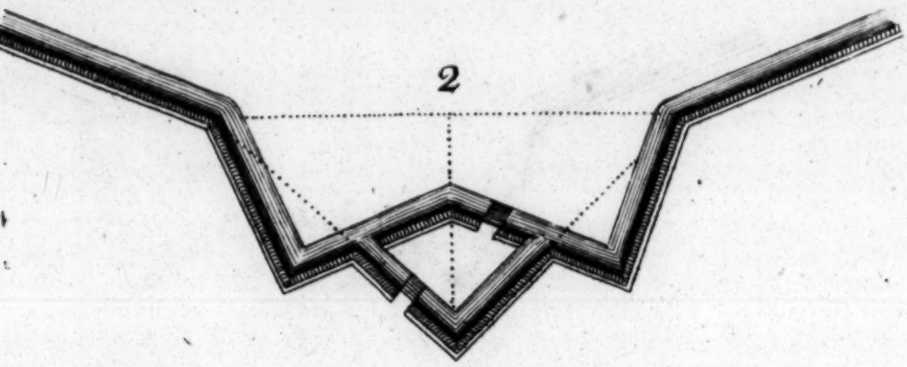


ADVANC'D DITCH

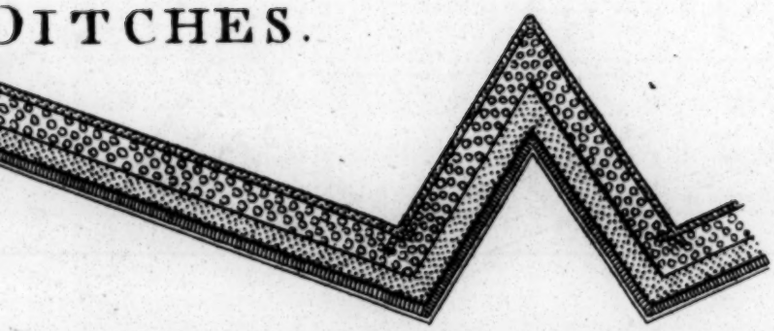


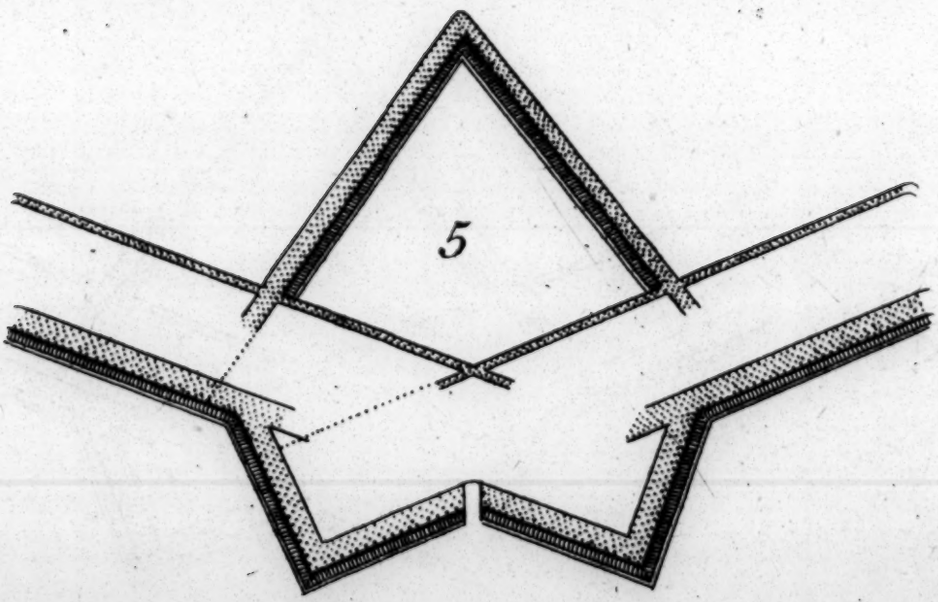


and BASTIONS.

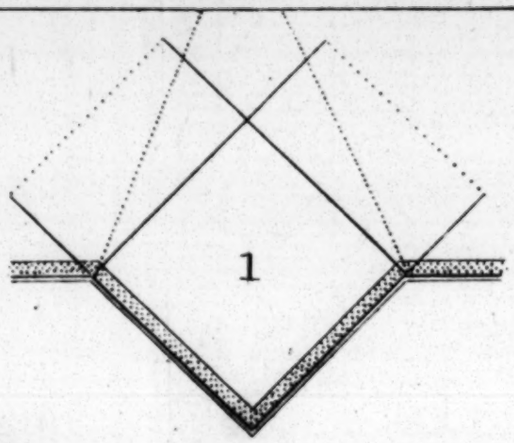


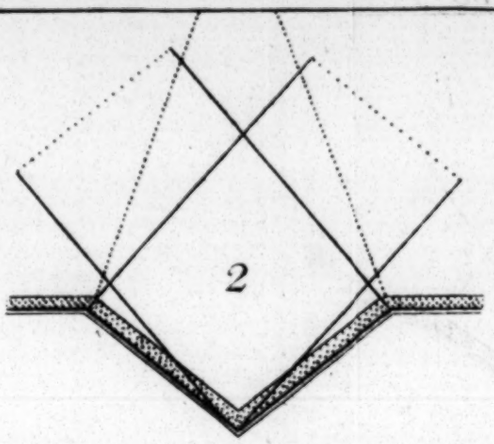
DITCHES.





Fathoms
100

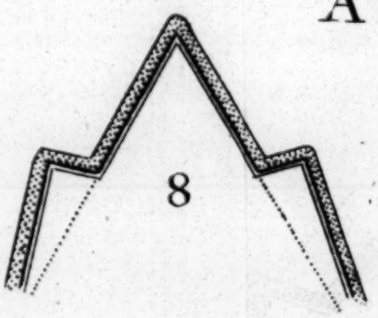


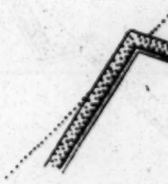


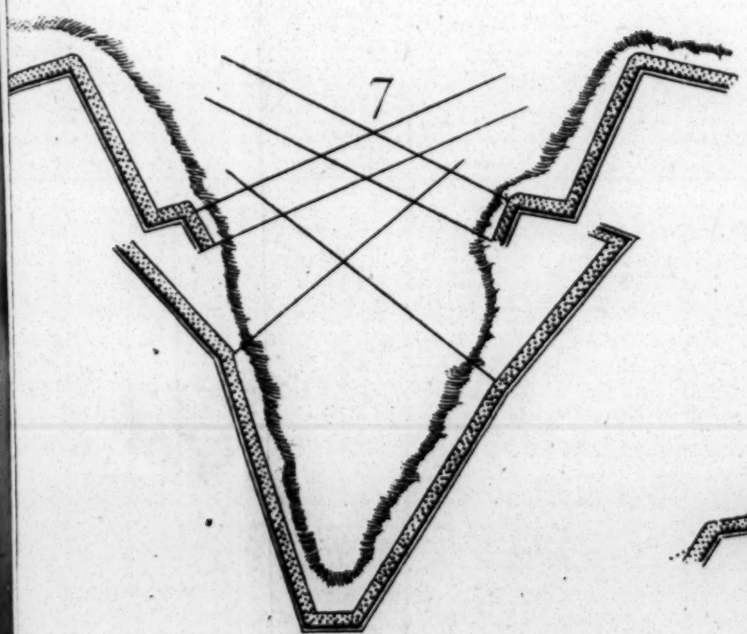


ANGLES

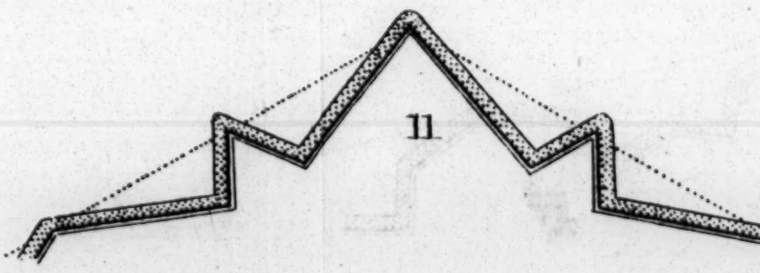


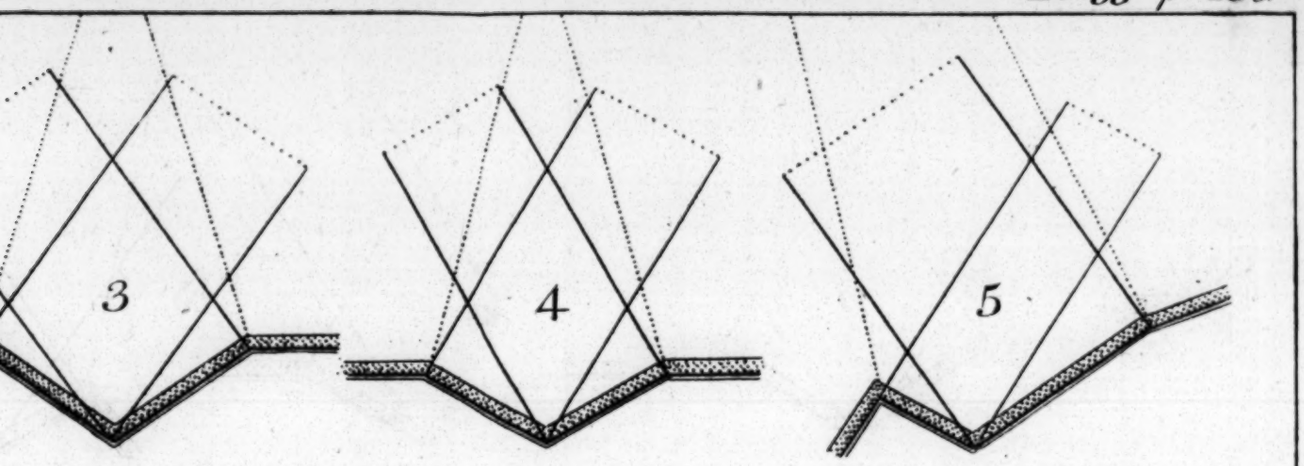




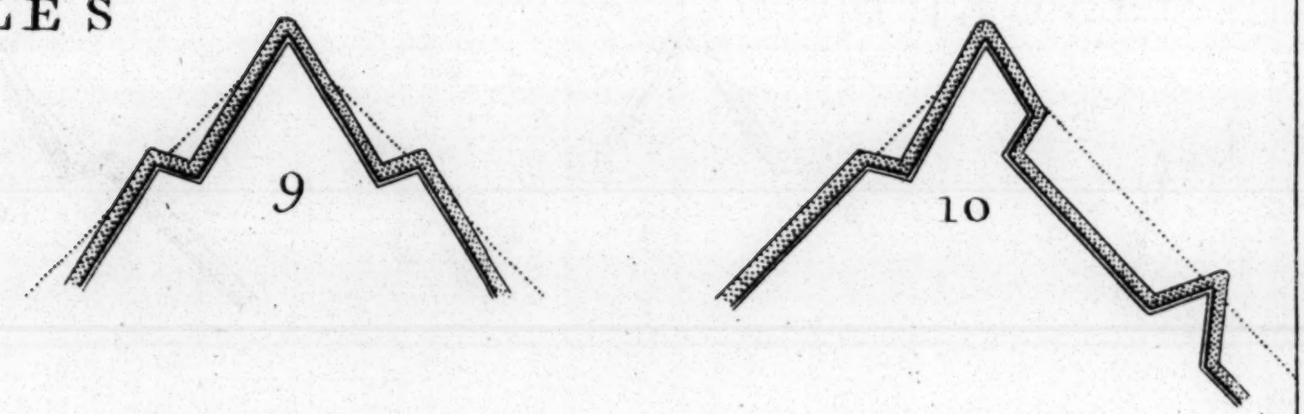




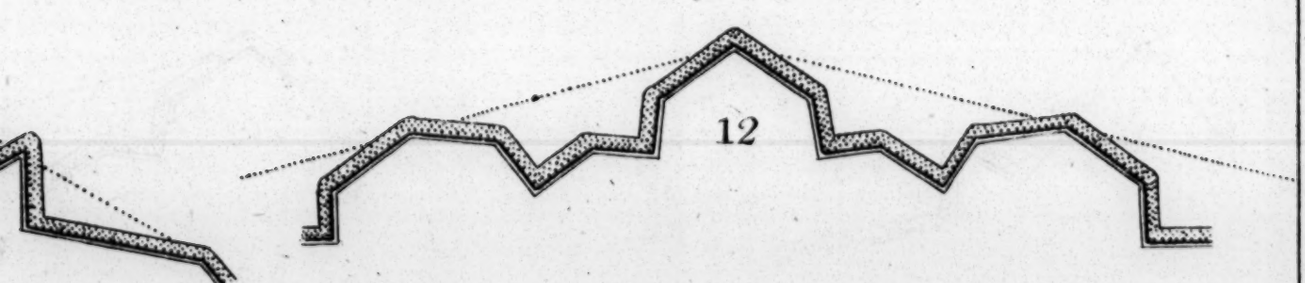


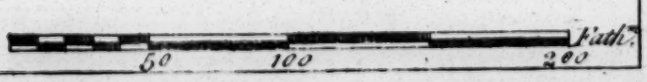


LES

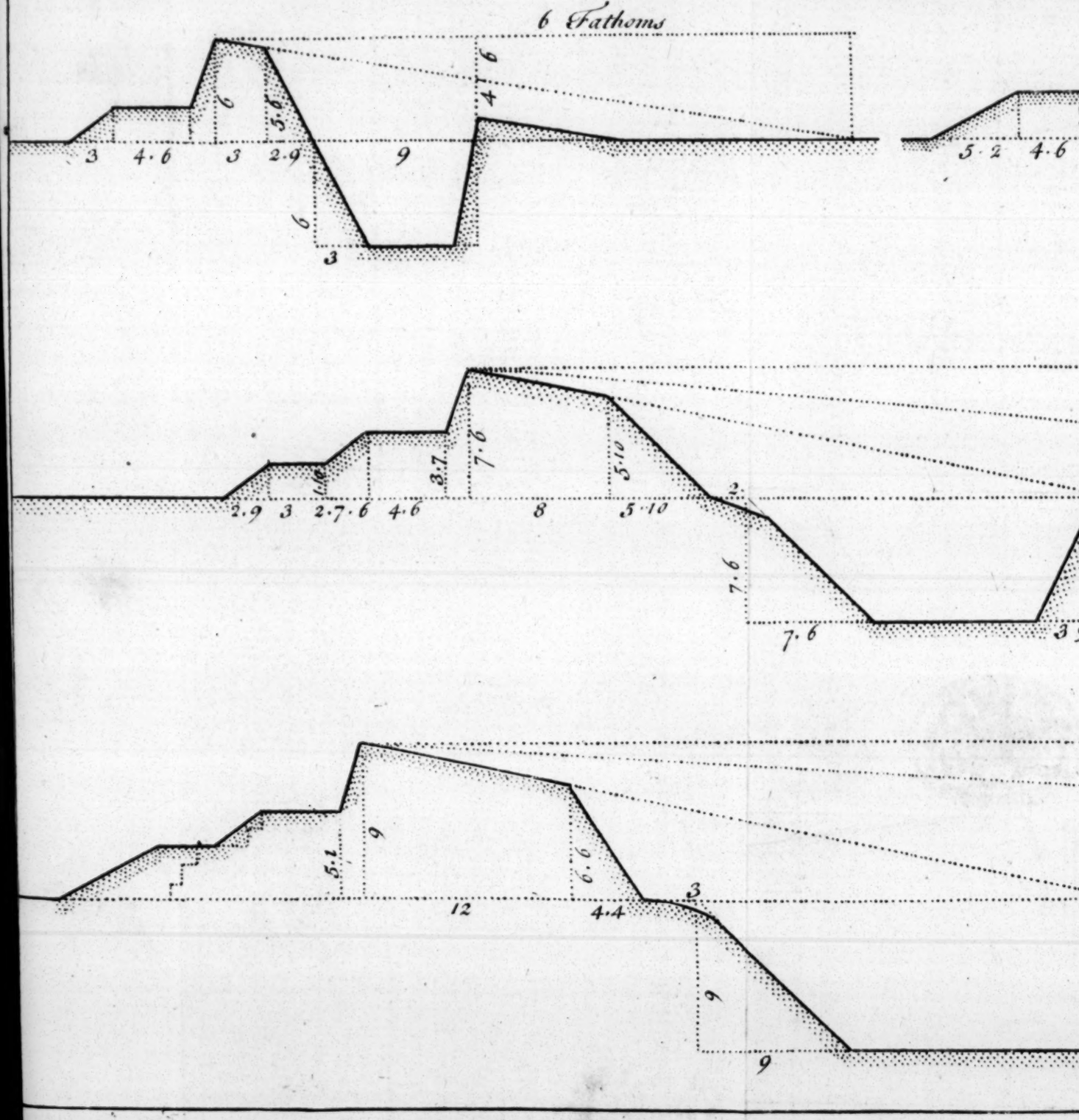








PROFIL S


6 Fathoms
6
5.6
4.6
3
4.6
3
2.9
9
6
3
5.2
4.6
1.6
3.7
7.6
5.10
2.9
3
2.7.6
4.6
8
5.10
2.
7.6
7.6
5.1
9
6.6
12
4.4
3
9
9

FILS

Pl. 36. p. 278.

